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# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-288580

(43)Date of publication of application : 27.10.1998

(51)Int.Cl.

G01N 21/05

H01L 49/00

(21)Application number : 09-095864

(71)Applicant : OLYMPUS OPTICAL CO LTD

(22)Date of filing : 14.04.1997

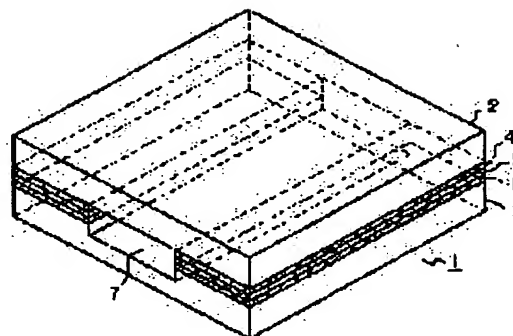
(72)Inventor : TAJIMA NOBUYOSHI  
SHINOHARA ETSUO  
KONDO SEIJI

## (54) FINE PASSAGE ELEMENT

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a fine passage element having an apparatus analyzing fluid passage allowing optical detection over a wavelength range from ultraviolet rays to visual rays and capable of being easily miniaturized.

**SOLUTION:** This fine passage element 1 is connected with a flat quartz glass substrate 2 and a quartz glass substrate 3 formed with a groove at least on one face via a laminated film constituted of a polysilicone thin film 4, an alkali ion-containing glass layer, e.g. a boro-silicate glass thin film 5, and a polysilicone thin film 6. An apparatus analyzing fluid passage 7 is formed with the space surrounded by the quartz glass substrate 2 and the quartz glass substrate 3 formed with the groove, the fluid passage 7 is formed on the quartz glass substrate excellent in light permeability in the wavelength range from ultraviolet rays to visible rays, and optical detection can be made in the wavelength range from ultraviolet rays to visible rays.



## LEGAL STATUS

[Date of request for examination]

19.03.2002

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

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**JAPANESE** [JP,10-288580,A]

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CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE  
INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS  
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**CLAIMS**

[Claim(s)]

[Claim 1] In respect of a side which a quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter A minute passage element characterized by intervening between a silicon layer of a pair formed on a field which confronts each other, and a silicon layer of said pair, providing an alkali ion content glass layer formed in contact with both silicon layer except for a field which touches a opening of said slot inside and this slot, and being joined in one.

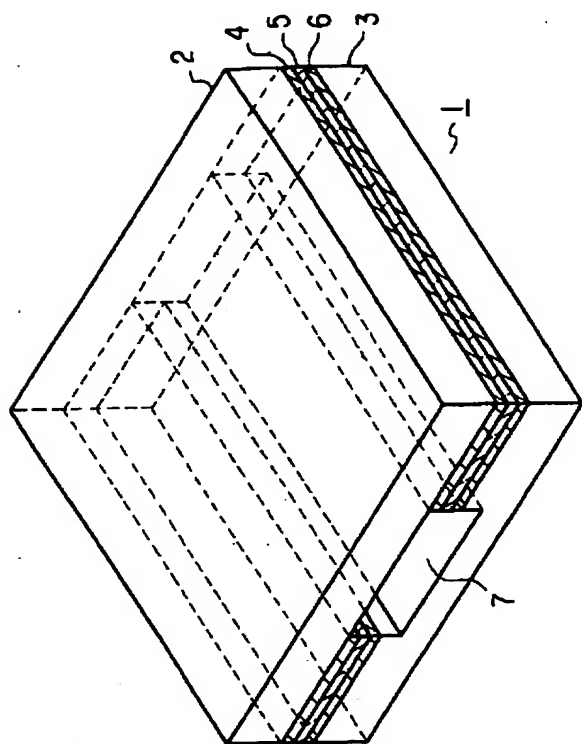
[Claim 2] In respect of a side which a quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter A silicon layer of a pair formed on a field which confronts each other except for a field which touches a opening of said slot inside and this slot, An alkali ion content glass layer which intervenes between silicon layers of said pair and is formed in contact with one silicon layer, A minute passage element characterized by intervening between silicon layers of said pair, providing silicon oxide formed in contact with a silicon layer of another side, and said alkali ion content glass layer, and being joined in one.

[Claim 3] Claim 1 characterized by preparing a reflective film in one [ at least ] external surface by the side of a non-plane of composition of a quartz-glass substrate of said minute passage element, or a minute passage element according to claim 2.

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[Translation done.]

Drawing selection **Representative drawing**



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**DETAILED DESCRIPTION**

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**[Detailed Description of the Invention]**

**[0001]**

**[The technical field to which invention belongs]** This invention relates to the fluid passage for instrumental analyses which used the glass substrate.

**[0002]**

**[Description of the Prior Art]** Generally, the fluid passage for instrumental analyses is constituted using capillaries, such as glass and stainless steel.

**[0003]** In order that this capillary might raise analysis capacity, it was usually used by length of about 50cm, but since this capillary was used rounding off it in the shape of a circle, the miniaturization was difficult.

**[0004]** Conventionally, the technology which forms a detailed slot in a silicon substrate etc. is reported, using a semiconductor manufacturing technology as a means to miniaturize. However, by the silicon substrate which consists of a semiconductor, when it was going to use for the capillary electrophoresis which dissociates by impressing the high voltage, in order that current might leak, there was a trouble that the high voltage could not be impressed.

**[0005]** Then, a detailed slot is processed into the glass substrate of an insulating material as fluid passage for instrumental analyses which leak of current does not produce, and the method of forming passage is learned.

**[0006]** For example, after performing recessing to a borosilicate glass substrate, it is carried by "Micromachining of Capillary Electrophoresis Injectors and Separators on Glass Chips and Evaluation of Flow at Capillary Interse" (Anal.Chem.1994, 66, and P177-184) about the passage which welded and formed this borosilicate glass substrate with heating.

**[0007]** This recessing forms a metal vacuum evaporatio no film to a borosilicate glass substrate, after it carries out patterning of the metal membrane with photolithography technology, it mak s a borosilicate glass substrate immersed in the solution which mixed fluoric acid, using this metal membrane as a mask, is etched, and forms U slot. Furthermore, the flat borosilicate glass substrate is heated and borosilicate glass welded [ which carried out recessing ] to superposition and 700 degrees C so that U slot may be plugged up.

**[0008]** To moreover, others "A New Fbrication Method of Borosilicate Glass Capillary Tubes with A slot is formed in a borosilicate glass substrate at Lateral Inlets and Outlets" (Analytical Methods & Instrumentation, Special Issue muTAS'96 p214 ). The technology which joins this borosilicate glass substrate and other flat borosilicate glass substrates with an anode plate conjugation method, and forms passage is indicated.

**[0009]** After make a borosilicate-glass substrate form a polish recon (poly-Si) thin film and carrying out patterning of the polish recon thin film with low-voltage chemical vapor growth (LPCVD) using photolithography technology to it, recessing makes a borosilicate-glass substrate immersed in the solution which mixed fluoric acid by using this polish recon thin film as a mask, etches, and, according to this technology, forms a slot.



[0010] And anode plate cementation is joined with heating, making voltage impress between the polish recon thin film on one borosilicate glass substrate, and the borosilicate glass substrate of another side.

[0011]

[Problem(s) to be Solved by the Invention] When carrying out separation analysis of the liquid conventionally using the fluid passage for instrumental analyses, detection of separation material is technique with common optical detection. As a substrate which constitutes the fluid passage for instrumental analyses, since borosilicate glass was used for both the conventional technology mentioned above, it absorbed the light of an ultraviolet wavelength region and had the trouble that optical detection in a short wavelength region could not be performed.

[0012] Then, this invention is crossed to a visible wavelength region from ultraviolet, and aims at offering the minute passage element which has easily the fluid passage for instrumental analyses which can be miniaturized possible [ optical detection ].

[0013]

[Means for Solving the Problem] This invention is the near field where a quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter, in order to attain the above-mentioned purpose. It intervenes between a silicon layer of a pair formed on a field which confronts each other except for a field which touches a opening of said slot inside and this slot, and a silicon layer of said pair, and it has an alkali ion content glass layer formed in contact with both silicon layer, and a minute passage element joined in one is offered.

[0014] Furthermore, this minute passage element equips a location by the side of a non-plane of composition of a quartz-glass substrate joined face to face applied to said passage on the other hand at least in a field with either a light reflex layer which has two or more openings, or a light absorption layer.

[0015] A slot (fluid passage) is formed in a quartz-glass substrate the above minute passage elements of a configuration excelled [ substrate ] in the permeability of light of a visible wavelength region from ultraviolet, and optical detection is attained in a wavelength region visible from ultraviolet. Moreover, in order to form detailed fluid passage on a quartz-glass substrate using a semiconductor manufacturing technology, a minute passage element is miniaturized.

[0016]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to details with reference to a drawing.

[0017] The rough configuration of the minute passage element as 1st operation gestalt by this invention is shown in drawing 1 , and it explains to it.

[0018] This minute passage element 1 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [ at least ] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, and the polish recon thin film 6 intervene, and is joined and constituted. Of the space surrounded by this quartz substrate 2 and the quartz-glass substrate 3 by which the slot was formed, the fluid passage 7 for instrumental analyses (fluid passage is called hereafter) is formed.

[0019] Next, with reference to drawing 2 (a) - (h) and drawing 3 (a) - (f), the formation production process of a minute passage element is explained.

[0020] First, as shown in drawing 2 (a), LPCVD is used on all the surfaces of the quartz-glass substrate 2, and the polish recon thin film 4 of a non dope is formed. In this operation gestalt, the thickness of the quartz-glass substrate 2 has the desirable quartz substrate 1mm or less which carried out double-sided polishing, and the thickness of the polish recon thin film 4 is 1 micrometer. It is desirable that it is the following.

[0021] Next, as shown in drawing 2 (b), the borosilicate glass thin film 5 is formed by sputtering

on one surface of said polish recon thin film 4. The thickness of this borosilicate glass thin film 5 is 1 micrometer. It is desirable that it is the following. As furthermore shown in drawing 2 (c), the spin coat of the positive type photoresist is carried out to the surface of the borosilicate glass thin film 5, and the resist film 8 is formed on it.

[0022] As shown in drawing 2 (d), with photolithography technology, patterning of the resist film 8 is carried out, and resist mask 8a is formed. As shown in drawing 2 (e), after removing the borosilicate glass thin film 5 exposed in the field except having been covered with resist mask 8a and removing the polish recon thin film 4 of further a lower layer by anisotropic etching (RIE), for example, reactive ion etching, as shown in drawing 2 (f), by the plasma asher, resist mask 8a is removed and the passage configuration substrate 10 which has a slot 9 is formed.

[0023] Next, as shown in drawing 2 (g), the polish recon thin film 6 of a non dope is formed by LPCVD on all the surfaces of another quartz-glass substrate 3. For this quartz-glass substrate 3, the thickness of the polish recon thin film 6 which the quartz substrate with a thickness of 1mm or less which carried out double-sided polishing is desirable, and forms is 1 micrometer. It is desirable that it is the following.

[0024] Next, as shown in drawing 2 (h), after carrying out the spin coat of the positive type photoresist to the surface of the polish recon thin film 6 and forming the resist thin film 11, as shown in drawing 3 (a), patterning of the resist mask 11a is carried out with photolithography technology.

[0025] And after removing the polish recon thin film 6 exposed by RIE, as are shown in drawing 3 (b), and it is shown in drawing 3 (c) by using resist mask 11a as a mask, a plasma asher removes resist mask 11a.

[0026] Next, as shown in drawing 3 (d), wet etching removes the portion which the quartz-glass substrate 3 exposed to the solution which mixed fluoric acid and ammonium fluoride, using as a mask the polish recon thin film 6 which was immersed and carried out patterning of the quartz-glass substrate 3, and the passage configuration substrate 13 which has a slot 12 is formed. For this slot 12, the depth of flute or width of face is 100 micrometers. It is desirable that it is the following.

[0027] Furthermore, as shown in drawing 3 (e), it piles up so that the amount of [ of said passage configuration substrate 10 and the passage configuration substrate 13 ] slot may agree, and it joins using an anode plate conjugation method, and the element substrate 14 is formed.

[0028] This anode plate cementation is performed by heating the whole substrate, impressing voltage between the polish recon thin film 4 and the polish recon thin film 6. The heating temperature at this time is about 350–500 degrees C, and applied voltage is 200–1000 (V). It is desirable.

[0029] Next, as shown in drawing 3 (f), RIE or wet etching removes the polish recon thin film of the surface of the joined element substrate 14 which is shown in this drawing (e), and the minute passage element 1 is constituted.

[0030] Although the silicon layer which consists of a polish recon thin film was used with this operation gestalt, you may be an amorphous silicon thin film, and this silicon thin film has a desirable non dope silicon thin film. Membrane formation of a silicon thin film can apply and form semiconductor membrane formation technology, such as not only LPCVD but plasma CVD, sputtering, ECR, vacuum evaporation, etc. Moreover, although said slot is linear [–like ], it may not be limited to it, may be a curvilinear configuration, or may be a wave-like. Moreover, the depth of flute or width of face is 150 micrometers. It is desirable that it is the following and the sentiment and dry etching which used semiconductor technology, mechanical processing, etc. can be used for recessing.

[0031] Although the borosilicate glass thin film was used as an alkali ion content glass layer with this operation gestalt, you may be a soda glass thin film etc.

[0032] Thus, since the slot (fluid passage) is formed in the quartz-glass substrate excellent in the permeability of the light of a visible wavelength region from ultraviolet, as for the constituted

minute passage element 1, optical detection is attained in a wavelength region visible from ultraviolet. For this minute passage element 1, it mainly consists of glass, and a silicon thin film is a non dope silicon thin film, and thickness is 1 micrometer. Since it is that of the following, when high-voltage impression is carried out as passage for capillary electrophoreses, leak of current which affects electrophoresis does not arise. Moreover, with this operation gestalt, since semiconductor process technology is applied, formation of detailed slot passage becomes easy and the miniaturization of a minute passage element can be realized.

[0033] Next, the rough configuration of the minute passage element as 2nd operation gestalt is shown in drawing 4, and it explains to it. Here, the same reference mark is given to the part equivalent to the configuration part and the configuration part of this operation gestalt which were shown in drawing 1.

[0034] This minute passage element 20 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [ at least ] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, silicon oxide (Si O<sub>2</sub>) 21, and the polish recon thin film 6 intervene, and is joined and constituted. The fluid passage 7 is formed of the space surrounded by this quartz-glass substrate 2 and the quartz-glass substrate 3 by which the slot was formed.

[0035] This minute passage element 20 is created by adding the production process which forms silicon oxide 21 by sputtering on the surface of the borosilicate glass thin film 5 between the drawing 2 (b) production processes and the (c) production processes which were mentioned above. At this time, the thickness of silicon oxide 21 is 500 micrometers. The following is desirable.

[0036] It becomes easy to join it, in order that such a minute passage element 20 may prevent the current leak by dielectric breakdown in the case of anode plate cementation in addition to the effect of the minute passage element 1 in the 1st operation gestalt mentioned above since the silicon oxide 21 which is an insulating material was made to intervene between the borosilicate glass thin film 5 and the polish recon thin film 6. Moreover, since the high voltage impresses between the polish recon thin film 4 and the polish recon thin film 6 and it becomes cheap at coincidence, it becomes thin to join the thickness of the borosilicate glass thin film 5 easy.

[0037] Next, drawing 5 shows the rough configuration of the minute passage element as 3rd operation gestalt.

[0038] This minute passage element 30 is the example of a configuration in which the polish recon thin film 31 was formed to one field of the minute passage element 20 of the 2nd operation gestalt. This minute passage element 30 can be formed in the drawing 3 (e) production process mentioned above by leaving without removing one polish recon thin film 4 or polish recon thin film 6 of a field, and removing the polish recon thin film of an another side side. In drawing 5, the example which has left the polish recon thin film 6 (31) is shown.

[0039] Thus, since the constituted minute passage element 30 forms the polish recon thin film 31 in one field, It adds to an operation and effect of the minute passage element 1 mentioned above and the minute passage element 20. A light emitting device and a photo detector are prepared in the quartz-glass substrate 2 side of a minute passage element top, incidence of the detection light is carried out from the quartz-glass substrate 2 side, in case the reflected light is detected and analyzed, the reflection factor of light becomes high and detection sensitivity improves.

[0040] In addition, in this operation gestalt, other members can be used for the polish recon thin film 31 as a reflective film of light, for example, metal thin films, such as aluminum, may be used for it, for example.

[0041] Next, drawing 6 shows the rough configuration of the minute passage element as 4th operation gestalt.

[0042] Moreover, the upper surface of the minute passage element 40 of this operation gestalt

is shown in drawing 7 (a), and the A-A cross section of this drawing (a) is shown in drawing 7 (b). However, let the inferior surface of tongue of the minute passage element 40 be a thing equivalent to the configuration of the upper surface of drawing 6. Here, the same reference mark is given to the part equivalent to the configuration part shown in the configuration part and drawing 5 of this operation gestalt.

[0043] This minute passage element 40 is the configuration which the polish recon thin film 31 and the polish recon thin film 41 were formed in both sides of the minute passage element 20 mentioned above, and formed two or more apertures 42 in the symmetrical location of the polish recon thin films 31 and 41 which are the direction of the fluid passage 7, and the direction which intersects perpendicularly, and face across this fluid passage 7.

[0044] These apertures 42a-42f and -- carry out incidence of the light from one field, and in order to function as an aperture for observation which detects the transmitted light from the field of another side, even if it does not condense especially detection light, they become detectable [ the material which passes through the specific part of passage ] in the case of optical analysis. Analysis of minute area is attained by making especially the aperture 42 minute.

[0045] Next, with reference to the formation production process of drawing 8 (a) - (e), formation of said minute passage element 40 is explained.

[0046] First, as shown in drawing 8 (a), the configuration of this operation gestalt is the element substrate which formed at the formation production process of the 2nd operation gestalt shown in drawing 4 mentioned above, and the same formation production process, and silicon oxide 21 was made to intervene between the passage configuration substrate 10 shown by drawing 3 (e), and the passage configuration substrate 13, and was joined using the anode plate conjugation method.

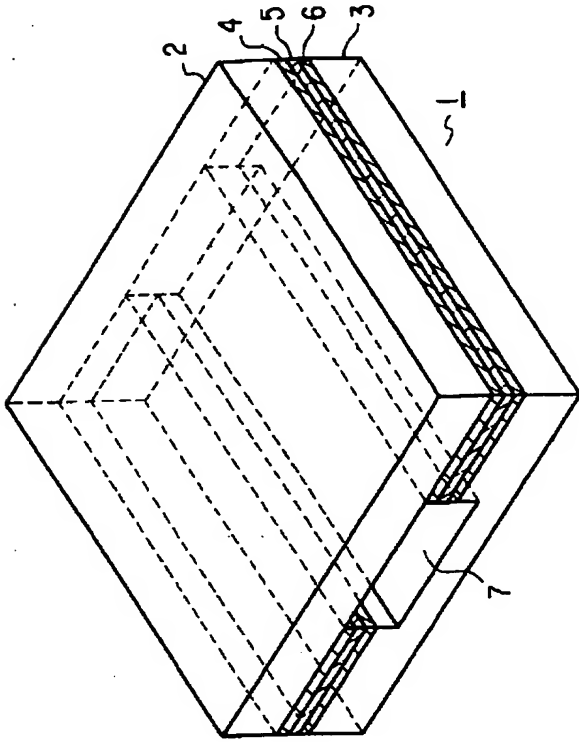
[0047] Next, as shown in drawing 8 (b), the spin coat of the photoresist is carried out on each surface of the polish recon thin films 4 and 6 which have covered both sides of the element substrate joined in this drawing (a), and the resist thin film 8 is formed.

[0048] And as shown in drawing 8 (c), patterning is carried out to the configuration of an aperture 42 where the resist thin film 8 is shown in drawing 6, using photolithography technology, and resist mask 8a is formed. As shown in drawing 8 (d), a part for the outcrop of the polish recon thin films 4 and 6 is removed using RIE by using resist mask 8a as a mask, and the polish recon thin films 4 and 6 which have an aperture 42 are formed.

[0049] Furthermore, as shown in drawing 8 (e), by the plasma asher, resist mask 8a is removed and the minute passage element 40 which has three apertures 42 to both sides, respectively is formed. Here, although the polish recon thin film of element both sides was illustrated in the condition of having been connected with the polish recon thin film of a substrate plane of composition, as shown in drawing 7 (b), the double-sided polish recon thin film 31 and the polish recon thin films 4 and 6 of a plane of composition may be separated on the side.

[0050]

Drawing selection ☐ Representative drawing ☒



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**TECHNICAL FIELD**

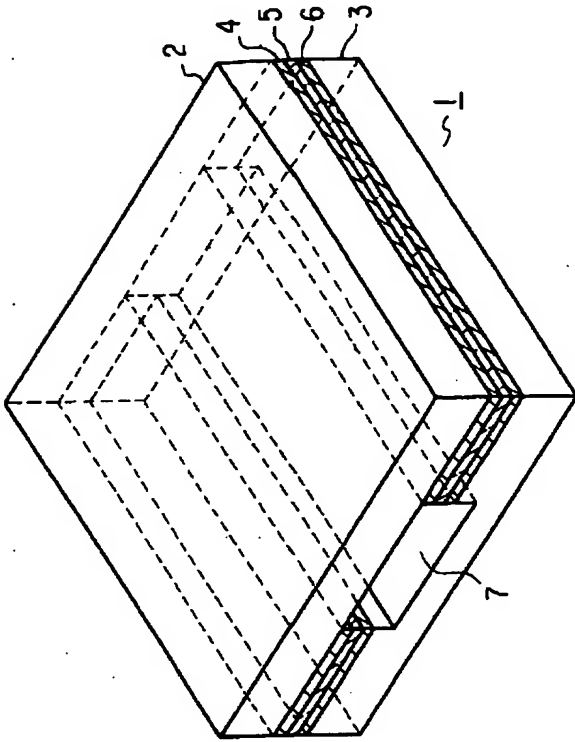
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Drawing selection ☐ Repr sentativ drawing ☒



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**PRIOR ART**

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[Description of the Prior Art] Generally, the fluid passage for instrumental analyses is constituted using capillaries, such as glass and stainless steel.

[0003] In order that this capillary might raise analysis capacity, it was usually used by length of about 50cm, but since this capillary was used rounding off it in the shape of a circle, the miniaturization was difficult.

[0004] Conventionally, the technology which forms a detailed slot in a silicon substrate etc. is reported, using a semiconductor manufacturing technology as a means to miniaturize. However, by the silicon substrate which consists of a semiconductor, when it was going to use for the capillary electrophoresis which dissociates by impressing the high voltage, in order that current might leak, there was a trouble that the high voltage could not be impressed.

[0005] Then, a detailed slot is processed into the glass substrate of an insulating material as fluid passage for instrumental analyses which leak of current does not produce, and the method of forming passage is learned.

[0006] For example, after performing recessing to a borosilicate glass substrate, it is carried by "Micromachining of Capillary Electrophoresis Injectors and Separators on Glass Chips and Evaluation of Flow at Capillary Interse" (Anal.Chem.1994, 66, and P177-184) about the passage which welded and formed this borosilicate glass substrate with heating.

[0007] This recessing forms a metal vacuum evaporatio film to a borosilicate glass substrate, after it carries out patterning of the metal membrane with photolithography technology, it makes a borosilicate glass substrate immersed in the solution which mixed fluoric acid, using this metal membrane as a mask, is etched, and forms U slot. Furthermore, the flat borosilicate glass substrate is heated and borosilicate glass welded [ which carried out recessing ] to superposition and 700 degrees C so that U slot may be plugged up.

[0008] To moreover, others "A New Fbrication Method of Borosilicate Glass Capillary Tubes with A slot is formed in a borosilicate glass substrate at Lateral Inlets and Outlets" (Analytical Methods & Instrumentation, Special Issue muTAS'96 p214 ). The technology which joins this borosilicate glass substrate and other flat borosilicate glass substrates with an anode plate conjugation method, and forms passage is indicated.

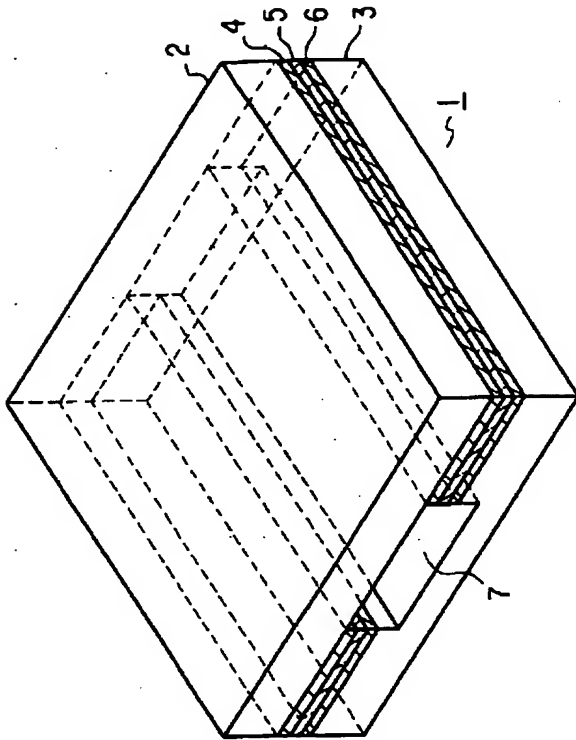
[0009] After making a borosilicate-glass substrate form a polish recon (poly-Si) thin film and carrying out patterning of the polish recon thin film with low-voltage chemical vapor growth (LPCVD) using photolithography technology to it, recessing makes a borosilicate-glass substrate immersed in the solution which mixed fluoric acid by using this polish recon thin film as a mask, etches, and, according to this technology, forms a slot.

[0010] And anode plate cementation is joined with heating, making voltage impress between the polish recon thin film on one borosilicate glass substrate, and the borosilicate glass substrate of another side.

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[Translation don .]

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**EFFECT OF THE INVENTION**

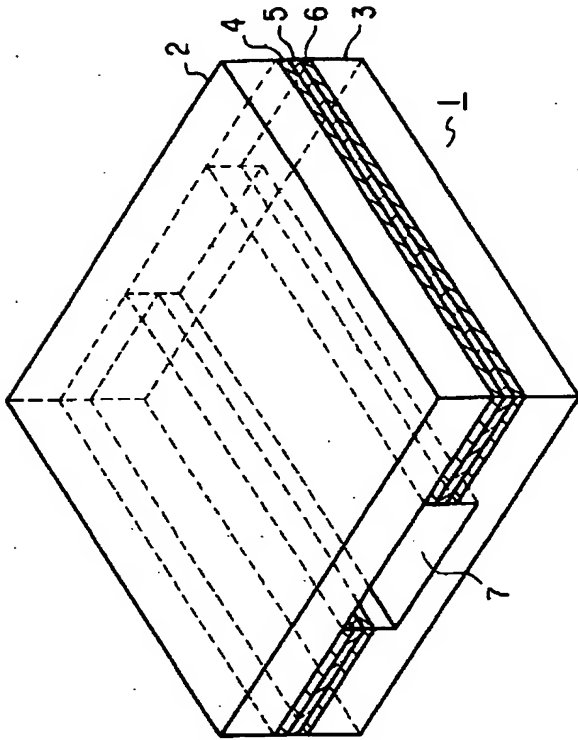
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[Effect of the Invention] As explained in full detail above, according to this invention, it can cross to a visible wavelength region from ultraviolet, and the minute passage element which has easily the fluid passage for instrumental analyses which can be miniaturized possible [ optical detection ] can be offered.

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**TECHNICAL PROBLEM**

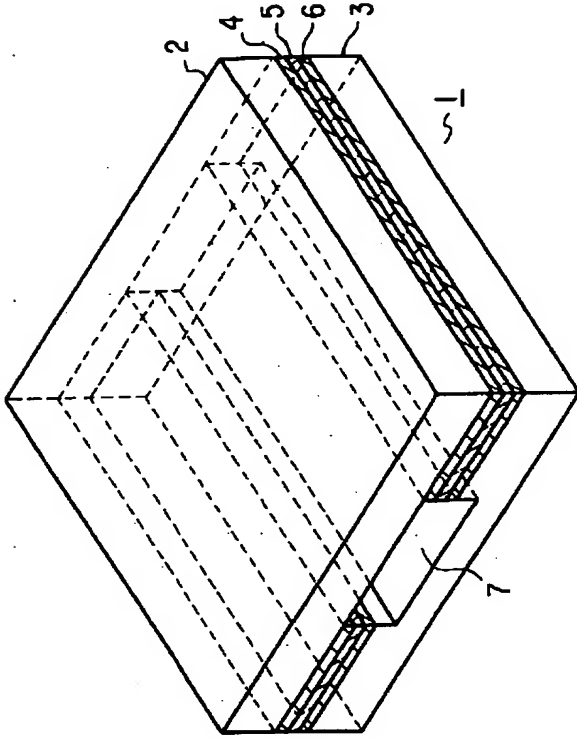
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[Problem(s) to be Solved by the Invention] When carrying out separation analysis of the liquid conventionally using the fluid passage for instrumental analyses, detection of separation material is technique with common optical detection. As a substrate which constitutes the fluid passage for instrumental analyses, since borosilicate glass was used for both the conventional technology mentioned above, it absorbed the light of an ultraviolet wavelength region and had the trouble that optical detection in a short wavelength region could not be performed. [0012] Then, this invention is crossed to a visible wavelength region from ultraviolet, and aims at offering the minute passage element which has easily the fluid passage for instrumental analyses which can be miniaturized possible [ optical detection ].

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**MEANS**

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[Means for Solving the Problem] This invention is the near field where a quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter, in order to attain the above-mentioned purpose. It intervenes between a silicon layer of a pair formed on a field which confronts each other except for a field which touches a opening of said slot inside and this slot, and a silicon layer of said pair, and it has an alkali ion content glass layer formed in contact with both silicon layer, and a minute passage element joined in one is offered.

[0014] Furthermore, this minute passage element equips a location by the side of a non-plane of composition of a quartz-glass substrate joined face to face applied to said passage on the other hand at least in a field with either a light reflex layer which has two or more openings, or a light absorption layer.

[0015] A slot (fluid passage) is formed in a quartz-glass substrate the above minute passage elements of a configuration excelled [ substrate ] in the permeability of light of a visible wavelength region from ultraviolet, and optical detection is attained in a wavelength region visible from ultraviolet. Moreover, in order to form detailed fluid passage on a quartz-glass substrate using a semiconductor manufacturing technology, a minute passage element is miniaturized.

[0016]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to details with reference to a drawing.

[0017] The rough configuration of the minute passage element as 1st operation gestalt by this invention is shown in drawing 1 , and it explains to it.

[0018] This minute passage element 1 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [ at least ] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, and the polish recon thin film 6 intervene, and is joined and constituted. Of the space surrounded by this quartz substrate 2 and the quartz-glass substrate 3 by which the slot was formed, the fluid passage 7 for instrumental analyses (fluid passage is called hereafter) is formed.

[0019] Next, with reference to drawing 2 (a) - (h) and drawing 3 (a) - (f), the formation production process of a minute passage element is explained.

[0020] First, as shown in drawing 2 (a), LPCVD is used on all the surfaces of the quartz-glass substrate 2, and the polish recon thin film 4 of a non dope is formed. In this operation gestalt, the thickness of the quartz-glass substrate 2 has the desirable quartz substrate 1mm or less which carried out double-sided polishing, and the thickness of the polish recon thin film 4 is 1 micrometer. It is desirable that it is the following.

[0021] Next, as shown in drawing 2 (b), the borosilicate glass thin film 5 is formed by sputtering on one surface of said polish recon thin film 4. The thickness of this borosilicate glass thin film 5

is 1 micrometer. It is desirable that it is the following. As furthermore shown in drawing 2 (c), the spin coat of the positive type photoresist is carried out to the surface of the borosilicate glass thin film 5, and the resist film 8 is formed on it.

[0022] As shown in drawing 2 (d), with photolithography technology, patterning of the resist film 8 is carried out, and resist mask 8a is formed. As shown in drawing 2 (e), after removing the borosilicate glass thin film 5 exposed in the field except having been covered with resist mask 8a and removing the polish recon thin film 4 of further a lower layer by anisotropic etching (RIE), for example, reactive ion etching, as shown in drawing 2 (f), by the plasma asher, resist mask 8a is removed and the passage configuration substrate 10 which has a slot 9 is formed.

[0023] Next, as shown in drawing 2 (g), the polish recon thin film 6 of a non dope is formed by LPCVD on all the surfaces of another quartz-glass substrate 3. For this quartz-glass substrate 3, the thickness of the polish recon thin film 6 which the quartz substrate with a thickness of 1mm or less which carried out double-sided polishing is desirable, and forms is 1 micrometer. It is desirable that it is the following.

[0024] Next, as shown in drawing 2 (h), after carrying out the spin coat of the positive type photoresist to the surface of the polish recon thin film 6 and forming the resist thin film 11, as shown in drawing 3 (a), patterning of the resist mask 11a is carried out with photolithography technology.

[0025] And after removing the polish recon thin film 6 exposed by RIE, as are shown in drawing 3 (b), and it is shown in drawing 3 (c) by using resist mask 11a as a mask, a plasma asher removes resist mask 11a.

[0026] Next, as shown in drawing 3 (d), wet etching removes the portion which the quartz-glass substrate 3 exposed to the solution which mixed fluoric acid and ammonium fluoride, using as a mask the polish recon thin film 6 which was immersed and carried out patterning of the quartz-glass substrate 3, and the passage configuration substrate 13 which has a slot 12 is formed. For this slot 12, the depth of flute or width of face is 100 micrometers. It is desirable that it is the following.

[0027] Furthermore, as shown in drawing 3 (e), it piles up so that the amount of [ of said passage configuration substrate 10 and the passage configuration substrate 13 ] slot may agree, and it joins using an anode plate conjugation method, and the element substrate 14 is formed.

[0028] This anode plate cementation is performed by heating the whole substrate, impressing voltage between the polish recon thin film 4 and the polish recon thin film 6. The heating temperature at this time is about 350–500 degrees C, and applied voltage is 200–1000 (V). It is desirable.

[0029] Next, as shown in drawing 3 (f), RIE or wet etching removes the polish recon thin film of the surface of the joined element substrate 14 which is shown in this drawing (e), and the minute passage element 1 is constituted.

[0030] Although the silicon layer which consists of a polish recon thin film was used with this operation gestalt, you may be an amorphous silicon thin film, and this silicon thin film has a desirable non dope silicon thin film. Membrane formation of a silicon thin film can apply and form semiconductor membrane formation technology, such as not only LPCVD but plasma CVD, sputtering, ECR, vacuum evaporation, etc. Moreover, although said slot is linear [—like ], it may not be limited to it, may be a curvilinear configuration, or may be a wave-like. Moreover, the depth of flute or width of face is 150 micrometers. It is desirable that it is the following and the sentiment and dry etching which used semiconductor technology, mechanical processing, etc. can be used for recessing.

[0031] Although the borosilicate glass thin film was used as an alkali ion content glass layer with this operation gestalt, you may be a soda glass thin film etc.

[0032] Thus, since the slot (fluid passage) is formed in the quartz-glass substrate excellent in the permeability of the light of a visible wavelength region from ultraviolet, as for the constituted minute passage element 1, optical detection is attained in a wavelength region visible from

ultraviolet. For this minute passage element 1, it mainly consists of glass, and a silicon thin film is a non dope silicon thin film, and thickness is 1 micrometer. Since it is that of the following, when high-voltage impression is carried out as passage for capillary electrophoresis, leak of current which affects electrophoresis does not arise. Moreover, with this operation gestalt, since semiconductor process technology is applied, formation of detailed slot passage becomes easy and the miniaturization of a minute passage element can be realized.

[0033] Next, the rough configuration of the minute passage element as 2nd operation gestalt is shown in drawing 4, and it explains to it. Here, the same reference mark is given to the part equivalent to the configuration part and the configuration part of this operation gestalt which were shown in drawing 1.

[0034] This minute passage element 20 makes the cascade screen which the flat quartz-glass substrate 2 and the quartz-glass substrate 3 with which the slot was formed in one [ at least ] field become from the polish recon thin film 4, the alkali ion content glass layer 5, for example, a borosilicate glass thin film, silicon oxide (SiO<sub>2</sub>) 21, and the polish recon thin film 6 intervene, and is joined and constituted. The fluid passage 7 is formed of the space surrounded by this quartz-glass substrate 2 and the quartz-glass substrate 3 by which the slot was formed.

[0035] This minute passage element 20 is created by adding the production process which forms silicon oxide 21 by sputtering on the surface of the borosilicate glass thin film 5 between the drawing 2 (b) production processes and the (c) production processes which were mentioned above. At this time, the thickness of silicon oxide 21 is 500 micrometers. The following is desirable.

[0036] It becomes easy to join it, in order that such a minute passage element 20 may prevent the current leak by dielectric breakdown in the case of anode plate cementation in addition to the effect of the minute passage element 1 in the 1st operation gestalt mentioned above since the silicon oxide 21 which is an insulating material was made to intervene between the borosilicate glass thin film 5 and the polish recon thin film 6. Moreover, since the high voltage impresses between the polish recon thin film 4 and the polish recon thin film 6 and it becomes cheap at coincidence, it becomes thin to join the thickness of the borosilicate glass thin film 5 easy.

[0037] Next, drawing 5 shows the rough configuration of the minute passage element as 3rd operation gestalt.

[0038] This minute passage element 30 is the example of a configuration in which the polish recon thin film 31 was formed to one field of the minute passage element 20 of the 2nd operation gestalt. This minute passage element 30 can be formed in the drawing 3 (e) production process mentioned above by leaving without removing one polish recon thin film 4 or polish recon thin film 6 of a field, and removing the polish recon thin film of an another side side. In drawing 5, the example which has left the polish recon thin film 6 (31) is shown.

[0039] Thus, since the constituted minute passage element 30 forms the polish recon thin film 31 in one field, It adds to an operation and effect of the minute passage element 1 mentioned above and the minute passage element 20. A light emitting device and a photo detector are prepared in the quartz-glass substrate 2 side of a minute passage element top, incidence of the detection light is carried out from the quartz-glass substrate 2 side, in case the reflected light is detected and analyzed, the reflection factor of light becomes high and detection sensitivity improves.

[0040] In addition, in this operation gestalt, other members can be used for the polish recon thin film 31 as a reflective film of light, for example, metal thin films, such as aluminum, may be used for it, for example.

[0041] Next, drawing 6 shows the rough configuration of the minute passage element as 4th operation gestalt.

[0042] Moreover, the upper surface of the minute passage element 40 of this operation gestalt is shown in drawing 7 (a), and the A-A cross section of this drawing (a) is shown in drawing 7

(b). However, let the inferior surface of tongue of the minute passage element 40 be a thing equivalent to the configuration of the upper surface of drawing 6. Here, the same reference mark is given to the part equivalent to the configuration part shown in the configuration part and drawing 5 of this operation gestalt.

[0043] This minute passage element 40 is the configuration which the polish recon thin film 31 and the polish recon thin film 41 were formed in both sides of the minute passage element 20 mentioned above, and formed two or more apertures 42 in the symmetrical location of the polish recon thin films 31 and 41 which are the direction of the fluid passage 7, and the direction which intersects perpendicularly, and face across this fluid passage 7.

[0044] These apertures 42a-42f and -- carry out incidence of the light from one field, and in order to function as an aperture for observation which detects the transmitted light from the field of another side, even if it does not condense especially detection light, they become detectable [ the material which passes through the specific part of passage ] in the case of optical analysis. Analysis of minute area is attained by making especially the aperture 42 minute.

[0045] Next, with reference to the formation production process of drawing 8 (a) - (e), formation of said minute passage element 40 is explained.

[0046] First, as shown in drawing 8 (a), the configuration of this operation gestalt is the element substrate which formed at the formation production process of the 2nd operation gestalt shown in drawing 4 mentioned above, and the same formation production process, and silicon oxide 21 was made to intervene between the passage configuration substrate 10 shown by drawing 3 (e), and the passage configuration substrate 13, and was joined using the anode plate conjugation method.

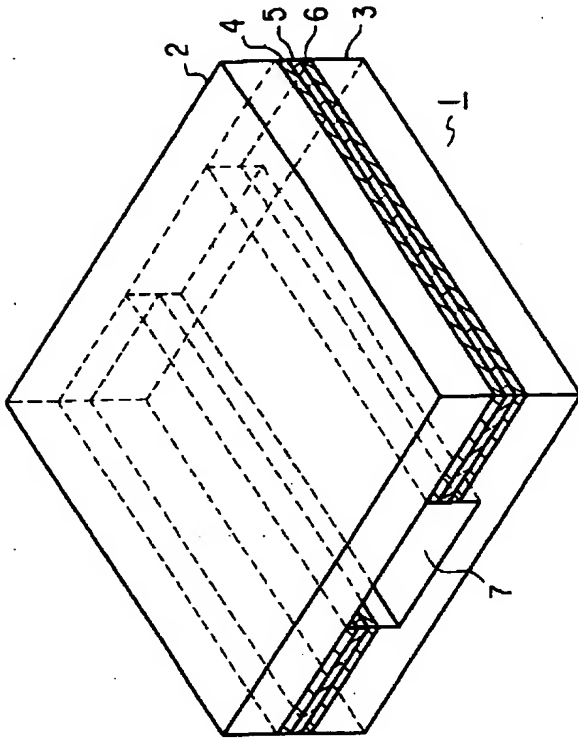
[0047] Next, as shown in drawing 8 (b), the spin coat of the photoresist is carried out on each surface of the polish recon thin films 4 and 6 which have covered both sides of the element substrate joined in this drawing (a), and the resist thin film 8 is formed.

[0048] And as shown in drawing 8 (c), patterning is carried out to the configuration of an aperture 42 where the resist thin film 8 is shown in drawing 6, using photolithography technology, and resist mask 8a is formed. As shown in drawing 8 (d), a part for the outcrop of the polish recon thin films 4 and 6 is removed using RIE by using resist mask 8a as a mask, and the polish recon thin films 4 and 6 which have an aperture 42 are formed.

[0049] Furthermore, as shown in drawing 8 (e), by the plasma asher, resist mask 8a is removed and the minute passage element 40 which has three apertures 42 to both sides, respectively is formed. Here, although the polish recon thin film of element both sides was illustrated in the condition of having been connected with the polish recon thin film of a substrate plane of composition, as shown in drawing 7 (b), the double-sided polish recon thin film 31 and the polish recon thin films 4 and 6 of a plane of composition may be separated on the side.

[0050]

Drawing selection **Representative drawing** ☒



[Translation done.]

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**JAPANESE** [JP,10-288580,A]

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CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE  
INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS  
CORRECTION OR AMENDMENT

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[Translation done.]

**\* NOTICES \***

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**DESCRIPTION OF DRAWINGS**

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**[Brief Description of the Drawings]**

[Drawing 1] It is drawing showing the rough configuration of the minute passage element as 1st operation gestalt by this invention.

[Drawing 2] Drawing 2 (a) - (h) is drawing for explaining the formation production process of a minute passage element.

[Drawing 3] Drawing 3 (a) - (f) is drawing for explaining the formation production process of the minute passage element following drawing 2 .

[Drawing 4] It is drawing showing the rough configuration of the minute passage element as 2nd operation gestalt.

[Drawing 5] It is drawing showing the rough configuration of the minute passage element as 3rd operation gestalt.

[Drawing 6] It is drawing showing the rough configuration of the minute passage element as 4th operation gestalt.

[Drawing 7] Drawing showing the configuration which saw the minute passage element which showed drawing 7 (a) to drawing 6 from the upper surface, and drawing 7 (b) are drawings showing the structure of the cross section of the A-A line of drawing 7 (a).

[Drawing 8] Drawing 8 (a) - (e) is drawing for explaining the formation production process of the minute passage element shown in drawing 6 .

[Drawing 9] It is drawing showing the rough configuration of the minute passage element as 5th operation gestalt.

[Drawing 10] Drawing showing the configuration which saw the minute passage element which showed drawing 10 (a) to drawing 9 from the upper surface, and drawing 10 (b) are drawings showing the structure of the cross section of the A-A line shown in drawing 10 (a).

[Drawing 11] It is drawing showing the rough configuration of the minute passage element as 6th operation gestalt.

[Drawing 12] Drawing showing the rough configuration of the minute passage element as 7th operation gestalt,

[Drawing 13] Drawing showing the configuration which saw the minute passage element which showed drawing 13 (a) to drawing 12 from the upper surface, and drawing 13 (b) are drawings showing the structure of the cross section of the A-A line shown in drawing 13 (a).

**[Description of Notations]**

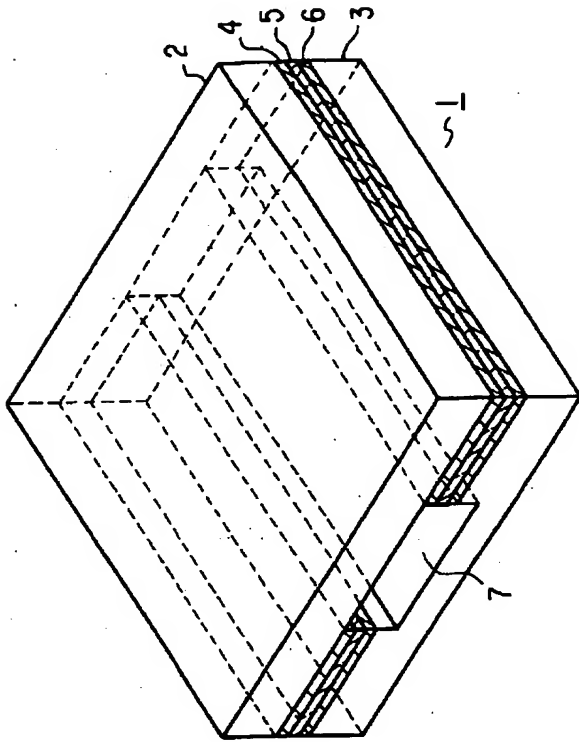
- 1 -- Minute passage element
- 2 3 -- Quartz-glass substrate
- 4 6 -- Polish recon thin film
- 5 -- Borosilicate glass thin film
- 7 -- Fluid passage
- 8 -- Resist thin film
- 9 -- Slot



8a -- Resist mask

[Translation done.]

Drawing selection **R** presentativ drawing 



[Translation done.]

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**JAPANESE** [JP,10-288580,A]

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CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE  
INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS  
CORRECTION OR AMENDMENT

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[Translation done.]

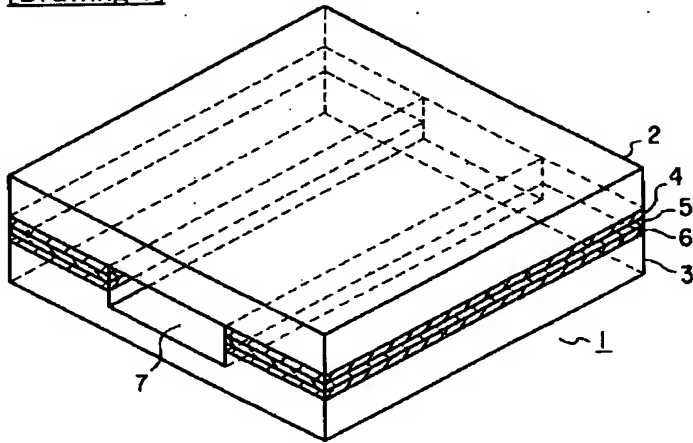
**\* NOTICES \***

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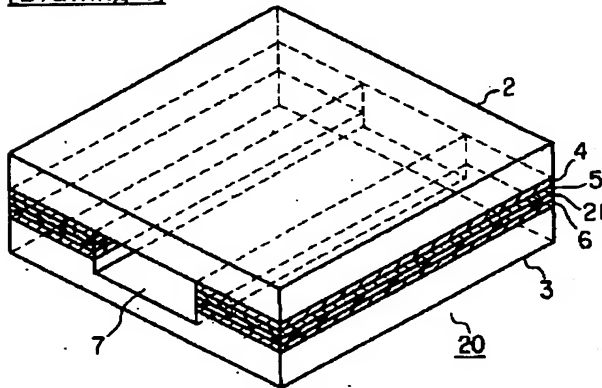
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**DRAWINGS**

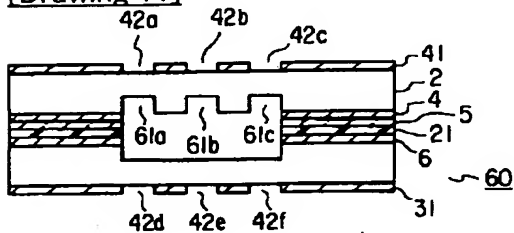
[Drawing 1]



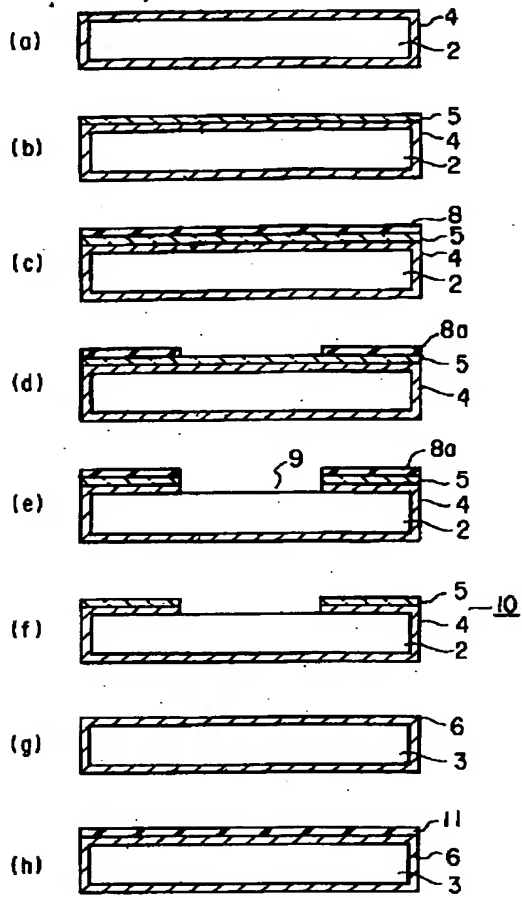
[Drawing 4]



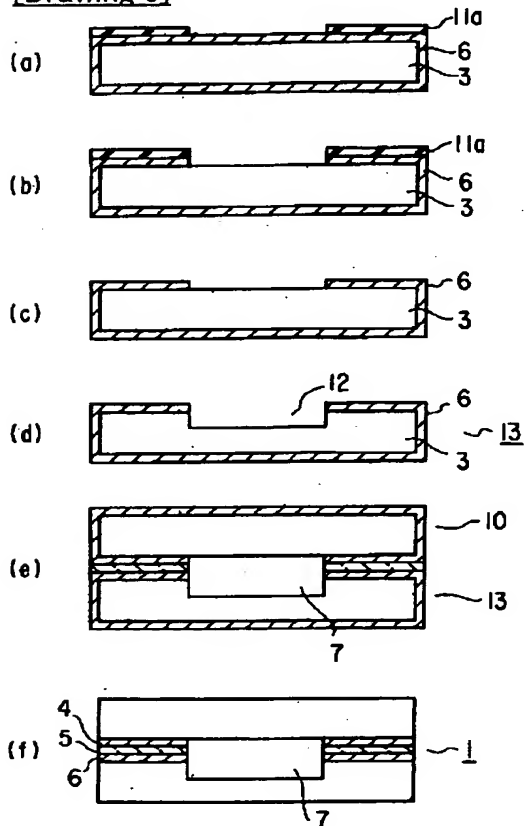
[Drawing 11]



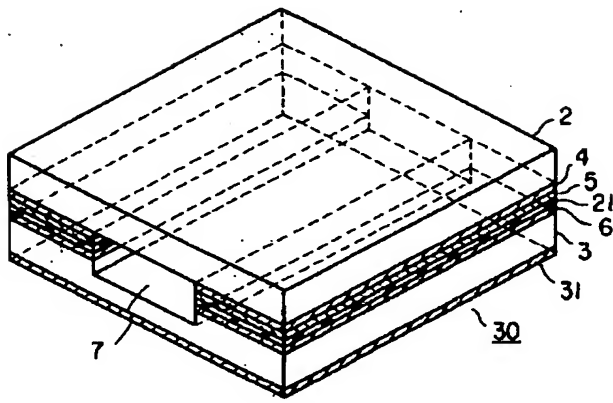
[Drawing 2]



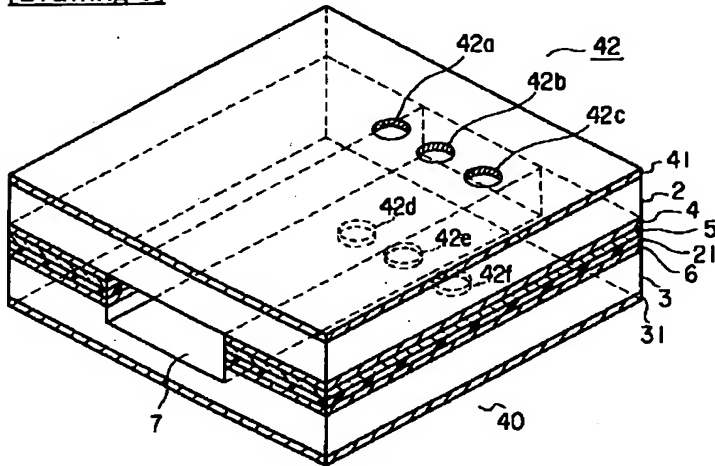
[Drawing 3]



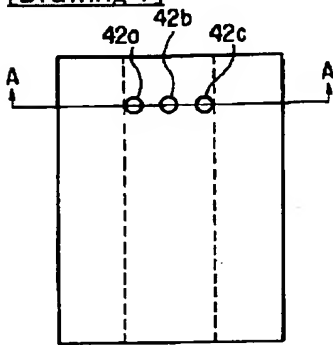
[Drawing 5]



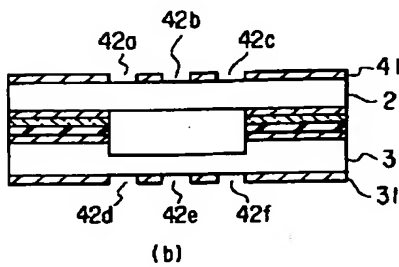
[Drawing 6]



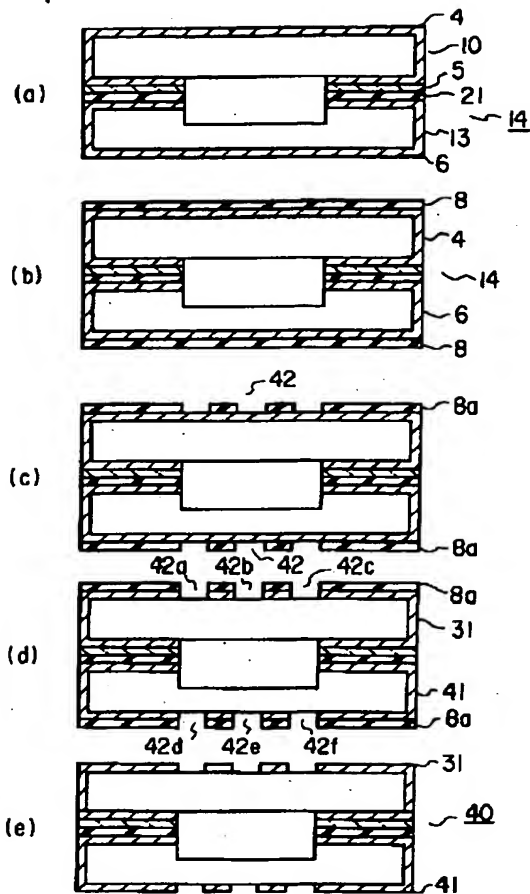
[Drawing 7]



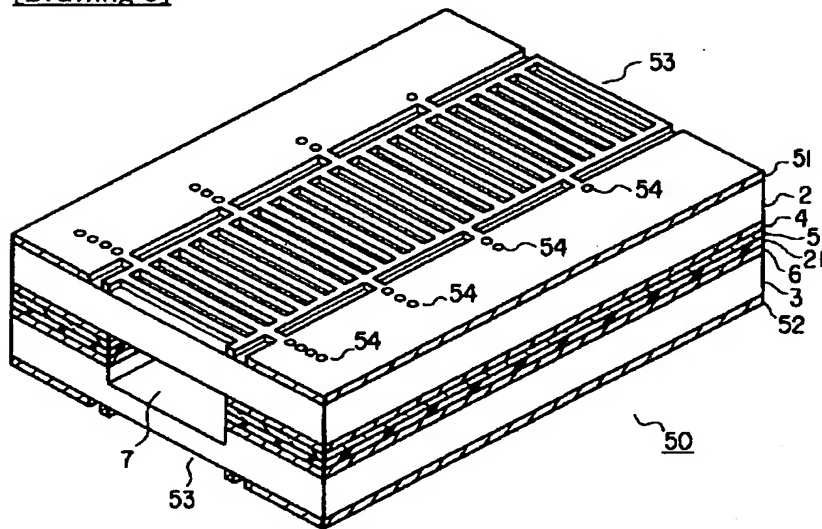
(a)



[Drawing 8]

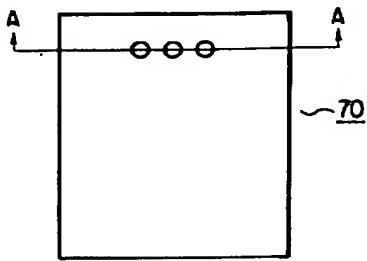


[Drawing 9]

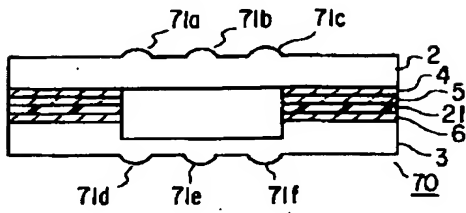


[Drawing 13]



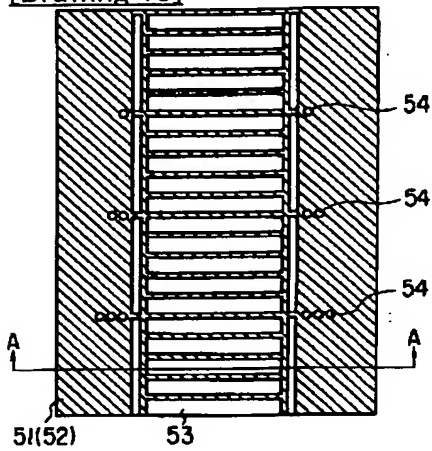


(a)

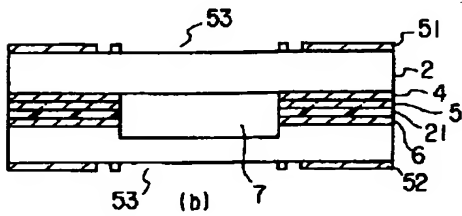


(b)

[Drawing 10]

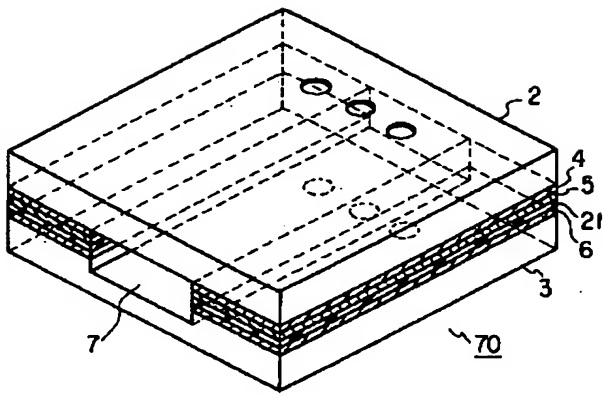


(a)



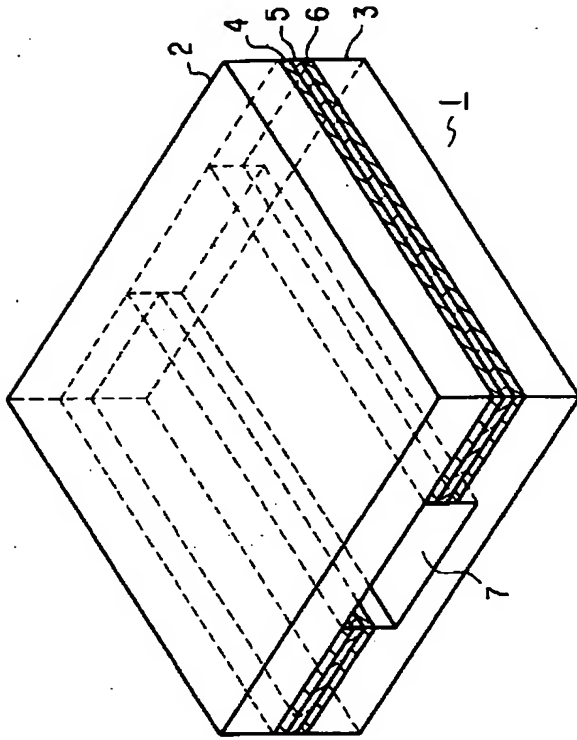
(b)

[Drawing 12]



[Translation done.]

Drawing selection ☒ Representative drawing ☐



[Translation done.]

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[Back to original](#) [JP,10-288580,A]

[Translation don .]

1. Amendment June 26, Heisei 14 (2002)

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**CORRECTION OR AMENDMENT**

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[Official Gazette Type] Printing of amendment by the convention of 2 of Article 17 of patent law

[Section partition] The 1st partition of the 6th section  
[Date of issue] June 26, Heisei 14 (2002. 6.26)

[Publication No.] JP,10-288580,A  
[Date of Publication] October 27, Heisei 10 (1998. 10.27)  
[Year copy format] Open patent official report 10-2886  
[Filing Number] Japanese Patent Application No. 9-95864  
[The 7th edition of International Patent Classification]

G01N 21/05  
H01L 49/00

[FI]

G01N 21/05  
H01L 49/00

[Procedure revision]  
[Filing Date] March 19, Heisei 14 (2002. 3.19)  
[Procedure amendment 1]  
[Document to be Amended] Specification  
[Item(s) to be Amended] Claim  
[Method of Amendment] Modification  
[Proposed Amendment]  
[Claim(s)]

[Claim 1] A quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared,  
A silicon layer of a pair formed on a field which confronts each other except for a field which touches said slot inside in respect of a side which a quartz-glass substrate of said pair counters,

An alkali ion content glass layer which intervenes between silicon layers of said pair and is formed in contact with both silicon layer,

A minute passage element characterized by providing and being joined in one.

[Claim 2] A quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared,

A silicon layer of a pair formed on a field which confronts each other except for a field which touches said slot inside in respect of a side which a quartz-glass substrate of said pair counters,

An alkali ion content glass layer which intervenes between silicon layers of said pair and is formed in contact with one silicon layer,

A minute passage element characterized by intervening between silicon layers of said pair, providing silicon oxide formed in contact with a silicon layer of another side, and said alkali ion content glass layer, and being joined in one.

[Claim 3] Claim 1 characterized by preparing either a light reflex layer or a light absorption layer in one field by the side of a non-plane of composition of a quartz-glass substrate of said minute passage element, or a minute passage element according to claim 2.

[Procedure amendment 2]

[Document to be Amended] Specification

[Item(s) to be Amended] 0013

[Method of Amendment] Modification

[Proposed Amendment]

[0013]

[Means for Solving the Problem] This invention is the near field where a quartz-glass substrate of a pair with which a slot where a side [ it counters ] forms passage in a field on the other hand at least is prepared, and a quartz-glass substrate of said pair counter, in order to attain the above-mentioned purpose. Except for a field which touches said slot inside, it intervenes between a silicon layer of a pair formed on a field which confronts each other, and a silicon layer of said pair, and it has an alkali ion content glass layer formed in contact with both silicon layer, and a minute passage element joined in one is offered.

[Procedure amendment 3]

[Document to be Amended] Specification

[Item(s) to be Amended] 0014

[Method of Amendment] Modification

[Proposed Amendment]

[0014] Furthermore, this minute passage element equips with either a light reflex layer or a light absorption layer one [ at least ] field by the side of the non-plane of composition of the quartz-glass substrate joined face to face.

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[Translation done.]



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a.

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平10-288580

(43) 公開日 平成10年(1998)10月27日

(51) Int.Cl.<sup>8</sup>

G 0 1 N 21/05

H 0 1 L 49/00

識別記号

F I

G 0 1 N 21/05

H 0 1 L 49/00

審査請求 未請求 請求項の数 3 O L (全 10 頁)

(21) 出願番号 特願平9-95864

(22) 出願日 平成9年(1997)4月14日

(71) 出願人 000000376

オリンパス光学工業株式会社

東京都渋谷区幡ヶ谷2丁目43番2号

(72) 発明者 田島 信芳

東京都渋谷区幡ヶ谷2丁目43番2号 オリ  
ンパス光学工業株式会社内

(72) 発明者 篠原 悦夫

東京都渋谷区幡ヶ谷2丁目43番2号 オリ  
ンパス光学工業株式会社内

(72) 発明者 近藤 聖二

東京都渋谷区幡ヶ谷2丁目43番2号 オリ  
ンパス光学工業株式会社内

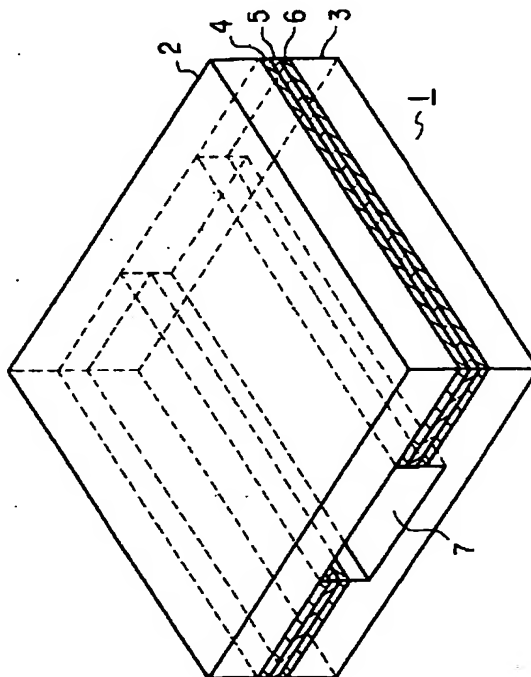
(74) 代理人 弁理士 鈴江 武彦 (外4名)

(54) 【発明の名称】 微小流路素子

(57) 【要約】

【課題】従来技術は、共に、機器分析用流体流路を構成する基板として、ホウケイ酸ガラスを用いているため、紫外波長域の光を吸収してしまい、短波長域での光学検出が出来ないという問題点があった。

【解決手段】本発明の微小流路素子1は、平坦な石英ガラス基板2と、少なくとも一方の面に溝が形成された石英ガラス基板3とが、ポリシリコン薄膜4、アルカリイオン含有ガラス層例えば、ホウケイ酸ガラス薄膜5、ポリシリコン薄膜6からなる積層膜を介させて接合して構成する。そのため、石英ガラス基板2と溝が形成された石英ガラス基板3とによって囲まれた空間によって、機器分析用流体流路7が形成されており、紫外から可視の波長域の光の透過性に優れた石英ガラス基板に流体流路が形成されており、紫外から可視の波長域において、光学的検出が可能になる。



## 【特許請求の範囲】

【請求項1】 対向する側の少なくとも一方向に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面及び該溝の開口に接する面を除き、対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在し、両シリコン層に接して形成されるアルカリイオン含有ガラス層と、を具備し、一体的に接合されることを特徴とする微小流路素子。

【請求項2】 対向する側の少なくとも一方向に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面及び該溝の開口に接する面を除き対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、一方のシリコン層に接して形成されるアルカリイオン含有ガラス層と、前記一対のシリコン層間に介在して、他方のシリコン層及び前記アルカリイオン含有ガラス層とに接して形成されるシリコン酸化膜と、を具備し、一体的に接合されることを特徴とする微小流路素子。

【請求項3】 前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面に反射膜を設けたことを特徴とする請求項1若しくは、請求項2に記載の微小流路素子。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、ガラス基板を用いた機器分析用流体流路に関する。

【0002】

【従来の技術】一般に、機器分析用流体流路は、ガラスやステンレス等の細管を用いて構成されている。

【0003】この細管は、分析能力を向上させるために、通常50cm程度の長さで利用されるが、この細管を円状に丸めて使用しているため小型化が困難であった。

【0004】従来、小型化する手段としては、半導体製造技術を用いて、シリコン基板等に微細な溝を形成する技術が報告されている。しかし、高電圧を印加して分離を行うキャピラリー電気泳動に用いようすると、半導体からなるシリコン基板では電流がリークするため、高電圧が印加できないという問題点があった。

【0005】そこで電流のリークが生じない機器分析用流体流路としては、絶縁体のガラス基板に微細な溝を加工して、流路を形成する方法が知られている。

【0006】例えば、「Micromachining of Capillary Electrophoresis Injectors and Separators on Glass Chips and Evaluation of Flow at Capillary Intersections」(Anal. Chem. 1994, 66, P177-184)には、ホウケイ酸ガラス基板に溝加工を施した後、該ホウケイ酸ガラス基板を加熱によって溶着して形成した流路につ

いて、掲載されている。

【0007】この溝加工は、ホウケイ酸ガラス基板に金属蒸着膜を成膜し、フォトリソグラフィ技術によって、金属膜をパターニングした後、この金属膜をマスクとして用いて、フッ酸を混合した溶液にホウケイ酸ガラス基板を浸漬させ、エッチングしてU溝を形成する。さらに、U溝を塞ぐように、溝加工したホウケイ酸ガラス基板に平坦なホウケイ酸ガラス基板を重ね合わせ、700℃まで加熱して溶着している。

【0008】また他に、「A New Fabrication Method of Borosilicate Glass Capillary Tubes with Lateral Inlets and Outlets」(Analytical Methods & Instrumentation, Special Issue  $\mu$ TAS '96 p214)には、ホウケイ酸ガラス基板に溝を形成し、このホウケイ酸ガラス基板と他の平坦なホウケイ酸ガラス基板を陽極接合法にて接合して流路を形成する技術が記載されている。

【0009】この技術によれば、溝加工は、ホウケイ酸ガラス基板に低圧化学的気相成長(LPCVD)によって、ポリシリコン(poly-Si)薄膜を成膜させ、フォトリソグラフィ技術を用いて、ポリシリコン薄膜をパターニングした後、該ポリシリコン薄膜をマスクとして、フッ酸を混合した溶液にホウケイ酸ガラス基板を浸漬させ、エッチングして溝を形成する。

【0010】そして、陽極接合は、一方のホウケイ酸ガラス基板上のポリシリコン薄膜と他方のホウケイ酸ガラス基板との間に電圧を印加させながら、加熱によって接合している。

【0011】

【発明が解決しようとする課題】従来、機器分析用流体流路を用いて液体を分離分析する場合、分離物質の検出は、光学的検出が一般的な手法である。前述した従来技術は、共に、機器分析用流体流路を構成する基板として、ホウケイ酸ガラスを用いているため、紫外波長域の光を吸収してしまい、短波長域での光学検出が出来ないという問題点があった。

【0012】そこで本発明は、紫外から可視の波長域に渡って、光学的検出が可能であり、且つ容易に小型化が可能な機器分析用流体流路を有する微小流路素子を提供することを目的とする。

【0013】

【課題を解決するための手段】本発明は上記目的を達成するために、対向する側の少なくとも一方向に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面及び該溝の開口に接する面を除き対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、両シリコン層に接して形成されるアルカリイオン含有ガラス層とを備え、一体的に接合される微小流路素子を提供する。

【0014】さらにこの微小流路素子は、対向して接合

する石英ガラス基板の非接合面側の少なくとも一方面で前記流路に掛かる位置に複数の開口部を有する、光反射層若しくは光吸収層のいずれか一方を備える。

【0015】以上のような構成の微小流路素子は、紫外から可視の波長域の光の透過性に優れた石英ガラス基板に溝（流体流路）が形成されており、紫外から可視の波長域において、光学的検出が可能になる。また、半導体製造技術を用いて、微細な流体流路を石英ガラス基板上に形成するため、微小流路素子が小型化される。

【0016】

【発明の実施の形態】以下、図面を参照して本発明の実施形態について詳細に説明する。

【0017】図1には、本発明による第1の実施形態としての微小流路素子の概略的な構成を示し説明する。

【0018】この微小流路素子1は、平坦な石英ガラス基板2と、少なくとも一方の面に溝が形成された石英ガラス基板3とが、ポリシリコン薄膜4、アルカリイオン含有ガラス層例えば、ホウケイ酸ガラス薄膜5、ポリシリコン薄膜6からなる積層膜を介在させて接合して構成されている。この石英基板2と溝が形成された石英ガラス基板3とによって囲まれた空間によって、機器分析用流体流路（以下、流体流路と称する）7が形成されている。

【0019】次に、図2（a）～（h）及び図3（a）～（f）を参照して、微小流路素子の形成工程について説明する。

【0020】まず、図2（a）に示すように、石英ガラス基板2の全表面上に、LPCVDを用いて、ノンドープのポリシリコン薄膜4を成膜する。本実施形態において、石英ガラス基板2の厚さは、1mm以下の両面研磨した石英基板が望ましく、また、ポリシリコン薄膜4の膜厚は、1 $\mu$ m以下であることが望ましい。

【0021】次に、図2（b）に示すように、前記ポリシリコン薄膜4の一方の表面上に、スパッタリングによって、ホウケイ酸ガラス薄膜5を成膜する。このホウケイ酸ガラス薄膜5の膜厚は、1 $\mu$ m以下であることが望ましい。さらに図2（c）に示すように、ホウケイ酸ガラス薄膜5の表面に、ポジ型フォトリソレジストをスピンコートし、レジスト膜8を成膜する。

【0022】図2（d）に示すように、フォトリソグラフィ技術によって、レジスト膜8をパターンニングして、レジストマスク8aを形成する。図2（e）に示すように、異方性エッチング、例えば、リアクティブイオンエッチング（RIE）によって、レジストマスク8aに覆われた以外の領域で露出するホウケイ酸ガラス薄膜5を除去し、さらに下層のポリシリコン薄膜4を除去した後、図2（f）に示すように、プラズマアッシャによって、レジストマスク8aを除去し、溝9を有する流路構成基板10を形成する。

【0023】次に、図2（g）に示すように、別の石英

ガラス基板3の全表面上に、LPCVDによって、ノンドープのポリシリコン薄膜6を成膜する。この石英ガラス基板3は、厚さ1mm以下の両面研磨した石英基板が望ましく、成膜するポリシリコン薄膜6の膜厚は、1 $\mu$ m以下であることが望ましい。

【0024】次に、図2（h）に示すように、ポリシリコン薄膜6の表面にポジ型フォトリソレジストをスピンコートし、レジスト薄膜11を成膜した後、図3（a）に示すように、フォトリソグラフィ技術によってレジストマスク11aをパターンニングする。

【0025】そして図3（b）に示すように、レジストマスク11aをマスクとして、RIEによって、露出するポリシリコン薄膜6を除去した後、図3（c）に示すように、プラズマアッシャによって、レジストマスク11aを除去する。

【0026】次に図3（d）に示すように、フッ酸とフッ化アンモニウムを混合した溶液に石英ガラス基板3を浸漬し、パターンニングしたポリシリコン薄膜6をマスクとして用いて、石英ガラス基板3の露出した部分をウェットエッチングにより除去し、溝12を有する流路構成基板13を形成する。この溝12は、溝の深さまたは幅が100 $\mu$ m以下であることが望ましい。

【0027】さらに、図3（e）に示すように、前記流路構成基板10及び流路構成基板13の溝部分が合致するように重ね、陽極接合法を用いて接合して、素子基板14を形成する。

【0028】この陽極接合は、ポリシリコン薄膜4とポリシリコン薄膜6との間に電圧を印加しつつ、基板全体を加熱して行う。この時の加熱温度は、350～500℃程度、印加電圧は200～1000（V）が望ましい。

【0029】次に、図3（f）に示すように、同図（e）に示す接合された素子基板14の表面のポリシリコン薄膜をRIEまたはウェットエッチングによって除去し、微小流路素子1を構成する。

【0030】本実施形態では、ポリシリコン薄膜からなるシリコン層を用いたが、アモルファスシリコン薄膜であってもよく、また、該シリコン薄膜はノンドープシリコン薄膜が望ましい。シリコン薄膜の成膜は、LPCVDだけでなく、プラズマCVD、スパッタリング、ECR、蒸着等の半導体成膜技術を応用して形成することが出来る。また、前記溝は、直線形状であるが、それに限定されず、曲線形状であっても、波形状であってもよい。また、溝の深さまたは幅は、150 $\mu$ m以下であることが望ましく、溝加工には、半導体技術を用いたウェット及びドライエッチングや機械的な加工などを用いることが出来る。

【0031】本実施形態では、アルカリイオン含有ガラス層として、ホウケイ酸ガラス薄膜を用いたが、この他に、ソーダガラス薄膜などであってもよい。

【0032】このように構成された微小流路素子1は、紫外から可視の波長域の光の透過性に優れた石英ガラス基板に溝（流体流路）が形成されているため、紫外から可視の波長域において、光学的検出が可能になる。この微小流路素子1は、主としてガラスより構成されており、シリコン薄膜は、ノンドープシリコン薄膜で、且つ膜厚が $1\mu\text{m}$ 以下であるため、キャピラリー電気泳動用流路として高電圧印加した場合においても、電気泳動に影響を与えるような電流のリークが生じない。また、本実施形態では、半導体プロセス技術を応用しているため、微細な溝流路の形成が容易になり、微小流路素子の小型化が実現できる。

【0033】次に図4には、第2の実施形態としての微小流路素子の概略的な構成を示し説明する。ここで、図1に示した構成部位と本実施形態の構成部位と同等の部位には、同じ参照符号を付している。

【0034】この微小流路素子20は、平坦な石英ガラス基板2と、少なくとも一方の面に溝が形成された石英ガラス基板3とが、ポリシリコン薄膜4、アルカリイオン含有ガラス層例えば、ホウケイ酸ガラス薄膜5、シリコン酸化膜（ $\text{SiO}_2$ ）21、ポリシリコン薄膜6からなる積層膜を介在させて接合して構成されている。この石英ガラス基板2と溝が形成された石英ガラス基板3とによって囲まれた空間によって、流体流路7が形成されている。

【0035】この微小流路素子20は、前述した図2（b）工程と（c）工程との間で、ホウケイ酸ガラス薄膜5の表面上に、スパッタリングによってシリコン酸化膜21を成膜する工程を加えることによって作成する。この時、シリコン酸化膜21の膜厚は、 $500\mu\text{m}$ 以下が望ましい。

【0036】このような微小流路素子20は、ホウケイ酸ガラス薄膜5とポリシリコン薄膜6との間に絶縁体であるシリコン酸化膜21を介在させているため、前述した第1の実施形態における微小流路素子1の効果に加え、陽極接合の際に、絶縁破壊による電流リークを防ぐため、接合が容易となる。また、同時にポリシリコン薄膜4とポリシリコン薄膜6との間に、高電圧が印加し安くなるため、ホウケイ酸ガラス薄膜5の膜厚が薄くとも接合が容易となる。

【0037】次に図5は、第3の実施形態としての微小流路素子の概略的な構成を示す。

【0038】この微小流路素子30は、第2の実施形態の微小流路素子20の一方の面にポリシリコン薄膜31を形成した構成例である。この微小流路素子30は、前述した図3（e）工程において、一方の面のポリシリコン薄膜4若しくはポリシリコン薄膜6を除去し、他方面のポリシリコン薄膜を除去せずに残しておくことで形成することができる。図5においては、ポリシリコン薄膜6（31）を残している例を示している。

【0039】このように構成された微小流路素子30は、一方の面にポリシリコン薄膜31を形成しているため、前述した微小流路素子1及び微小流路素子20の作用・効果に加えて、微小流路素子の上面の石英ガラス基板2の側に、発光素子と受光素子を設けて、石英ガラス基板2の側から検出光を入射し、その反射光を検出して分析する際、光の反射率が高くなり検出感度が向上する。

【0040】なお、本実施形態においては、例えば、ポリシリコン薄膜31は、光の反射膜として他の部材を用いることができ、例えば、アルミニウムなどの金属薄膜を用いてもよい。

【0041】次に図6は、第4の実施形態としての微小流路素子の概略的な構成を示す。

【0042】また、図7（a）には、本実施形態の微小流路素子40の上面を示し、図7（b）には、同図（a）のA-A断面を示す。但し、微小流路素子40の下面は、図6の上面の形状と同等であるものとする。ここで、本実施形態の構成部位と図5に示した構成部位と同等の部位には、同じ参照符号を付している。

【0043】この微小流路素子40は、前述した微小流路素子20の両面に、ポリシリコン薄膜31およびポリシリコン薄膜41が形成され、流体流路7の方向と直交する方向で、該流体流路7を挟むポリシリコン薄膜31、41の対称的位置に複数の窓42を形成した構成である。

【0044】これらの窓42a、～、42f、…は、一方の面から光を入射し、他方の面から透過光を検出する観測用窓として機能するため、光学的分析の際、特に検出光を集光しなくとも流路の特定の部位を通過する物質の検出が可能となる。特に窓42を微小にすることにより、微小エリアの分析が可能となる。

【0045】次に図8（a）～（e）の形成工程を参照して、前記微小流路素子40の形成について説明する。

【0046】まず、図8（a）に示すように、本実施形態の構成は、前述した図4に示した第2の実施形態の形成工程と同様な形成工程で形成し、図3（e）で示した流路構成基板10と流路構成基板13の間にシリコン酸化膜21を介在させて、陽極接合法を用いて接合した素子基板である。

【0047】次に、図8（b）に示すように、同図（a）で接合した素子基板の両面を覆っているポリシリコン薄膜4、6のそれぞれの表面上にフォトリソグراف技術を用いて、レジスト薄膜8を成膜する。

【0048】そして図8（c）に示すように、フォトリソグراف技術を用いて、レジスト薄膜8を図6に示すような窓42の形状にパターニングして、レジストマスク8aを形成する。図8（d）に示すように、レジストマスク8aをマスクとしてRIEを用いて、ポリシリコン薄膜4、6の露出部分を除去し、窓42を有するポリ

シリコン薄膜 4、6 を形成する。

【0049】さらに、図 8 (e) に示すように、プラズママッシャによって、レジストマスク 8a を除去し、それぞれ両面に 3 つの窓 42 を有する微小流路素子 40 を形成する。ここで、素子両面のポリシリコン薄膜を基板接合面のポリシリコン薄膜と繋がった状態で図示したが、図 7 (b) に示すように、両面のポリシリコン薄膜 31 と接合面のポリシリコン薄膜 4、6 とは側面にて分離されていてもよい。

【0050】本実施形態の微小流路素子 40 は、前述した微小流路素子 1、20 の作用・効果に加えて、微小流路素子の両面に流路の特定の部位を通過する物質の検出を可能にする窓 42 を有している。

【0051】なお、本実施形態の各構成は、各種変形、変更が可能である。例えば、ポリシリコン薄膜 31、41 は、光の透過率の低い他の膜に変更することが可能であり、例えば、スパッタリングや蒸着やメッキなどによって形成したアルミニウム等の金属薄膜を用いてもよい。

【0052】また、窓 42 は素子の両面に設けたが、光学検出の際、光の反射を利用する場合はどちらか片方の面に設けてもよい。

【0053】次に図 9 には、第 5 の実施形態として、泳動観察窓を有する微小流路素子の概略的な構成を示し説明する。図 10 (a) には、この微小流路素子の上面を示し、図 10 (b) は、同図 (a) に示す A-A 線の断面を示す。また、本実施形態の微小流路素子の下面の構成は、上面の構成と同等である。

【0054】この微小流路素子 50 は、第 2 の実施形態の微小流路素子 20 の両面にポリシリコン薄膜 51、52 を形成し、流体流路 7 の方向と直交する方向の長方形で、該流体流路 7 を挟むポリシリコン薄膜 51、52 の対称的な位置に、流体流路 7 の方向に沿って一定間隔を開けて、ラダー状に配置された複数の窓 53 を形成し、さらに、これらの窓 53 を一定の数毎に区切る目盛 54 を形成して構成する。この微小流路素子 50 は、図 8 に示した微小流路素子 40 の形成工程と同じ形成工程で、素子基板両面に形成するレジストマスクのパターン形状を変えることにより構成できる。

【0055】このような微小流路素子 50 は、微小流路素子 1 及び 20 の作用・効果に加えて、素子基板の両面に流体流路に沿って、一定間隔を開けて配置された複数の窓 53 及び目盛 54 は、泳動状況を観測する定規として働き、分析対象物の泳動状況の追跡が容易となる。

【0056】なお、本実施形態の各構成は、当然、各種変形、変更が可能である。例えば、ポリシリコン薄膜 51 及び 52 は、例えばスパッタリングや蒸着やメッキ等によって形成されたアルミニウム等の金属薄膜でもよく、光の透過率の低い他の膜に変更することができる。また、これらの窓 53 は、素子基板の両面に設けたが、

光学検出の際、光の反射を利用する場合は、どちらか片方の面に設けて構成してもよい。

【0057】次に、第 6 の実施形態として、光路長を延長した微小流路素子について図 11 により説明する。

【0058】図 11 は、この実施形態の概略的な構成を示す断面図であり、この微小流路素子 60 の基本的な構成は、図 6 及び図 7 に示した第 4 の実施形態の微小流路素子 40 の構成とほぼ同様であり、前記第 4 の実施形態とは、石英ガラス基板 2 の内側に複数の窪みを形成した点が異なる実施形態となっている。なお、微小流路素子 60 の上面 (ポリシリコン薄膜 41) 側及び下面 (ポリシリコン薄膜 31) 側の構成についても、第 4 の実施形態と同様に、上面側、下面側ともに、それぞれ 3 つの窓 42a~42c (上面側)、42d~42f (下面側) を設けた構成となっている。

【0059】この微小流路素子 60 は、微小流路素子 40 の流体流路 7 を構成する一方の石英ガラス基板の内側に、複数の窪み 61a、61b、61c を形成する。これらの窪み 61a、61b、61c は、窓 42 の内側に構成されている。本実施形態では、3 つの窪みを記載しているが、これに限定されるものではない。

【0060】このように構成された微小流路素子 60 は、前述した微小流路素子 1、20 及び 40 の作用・効果に加えて、流体流路 7 の光学検出用窓 42 の内側に複数の窪みを形成しているため、検出部の光路長が長くなり検出感度が向上する。

【0061】なお、本実施形態の各構成は、当然、各種変形、変更が可能である。例えば、これらの窪み 61a、61b、61c は、流体流路を構成する石英ガラス基板の一方の内側に設けたが、両方の石英ガラス基板の内側に設けることもできる。また、素子基板の両面に設けた窓 42 を有するポリシリコン薄膜 31、41 は、共に省略することもできる。

【0062】次に第 7 の実施形態として、レンズを備える微小流路素子の概略的な構成について説明する。図 12 には、本実施形態の微小流路素子の概略的な構成を示し、図 13 (a) には、この微小流路素子の上面の構成を示し、図 13 (b) には、同図 (a) に示す A-A 線の断面構成を示す図である。また、この微小流路素子の下面の構成は、上面の構成と同じである。

【0063】この微小流路素子 70 は、微小流路素子 20 を構成する石英ガラス基板 2、3 の流体流路 7 上方で、流体流 7 と直交する方向に配列される、複数の凸レンズ形状の突起部 71a~71f を有して構成される。

【0064】この微小流路素子 70 は、前述した微小流路素子 1 及び 20 の構成に加えて、素子基板の両面に凸レンズ形状の突起部 71a~71f を複数、形成したものであり、これらの突起部 71a~71f は、一方面の突起部から光を入射し、他方面の突起部から透過光を検出すると、入射光を集光する働きがあり検出感度が向上

する。なお、本実施形態では、凸レンズ型の6つの突起部を形成したが、これに限定されるものではなく、同じ機能として作用する範囲で形状の変形やそれらの数の変更が可能である。

【0065】以上の実施形態について説明したが、本明細書には以下のような発明も含まれている。

【0066】(1) 対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板にそれぞれ接して介在し、前記溝を除く領域上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、両シリコン層に接して形成されるアルカリイオン含有ガラス層とを具備し、一体的に接合されることを特徴とする微小流路素子。

【0067】本発明は、第1の実施形態に対応する。

【0068】本発明の微小流路素子は、紫外から可視の波長域の光の透過性に優れた石英ガラス基板により流路が形成されており、紫外から可視の波長域に渡って、光学的検出が可能である。また、微小流路素子は主に石英ガラスより構成されており、シリコン薄膜は、ノンドープシリコン薄膜で且つ1 $\mu$ m以下の膜厚で形成するため、キャピラリー電気泳動用流路として高電圧印加した場合においても、電気泳動に影響を与えるような電流のリークは生じない。また、前記微小流路素子は、半導体製造技術を利用して、微細な流体流路を有する小型化が可能である。

【0069】(2) 対向する側の少なくとも一方面に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板にそれぞれ接して介在し、前記溝を除く領域上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、一方のシリコン層に接して形成されるアルカリイオン含有ガラス層と、前記一対のシリコン層間に介在して、他方のシリコン層及び前記アルカリイオン含有ガラス層とに接して形成されるシリコン酸化膜とを備え、一体的に接合される微小流路素子。

【0070】少なくとも一方に流路を形成する溝が設けられてある一対の石英基板と、石英基板に接して石英基板間に設けられた一対のシリコン層と、一対のシリコン層間に設けられたアルカリイオン含有ガラス層およびシリコン酸化膜層とからなることを特徴とする微小流路素子。

【0071】本発明は、第2～第7の実施形態に対応する。

【0072】本発明の微小流路素子は、(1)項の構成による作用・効果に加えて、アルカリイオン含有ガラス薄膜とシリコン薄膜の間に絶縁体であるシリコン酸化膜を介在させているため、陽極接合の際に、絶縁破壊による電流リークを防止し、接合が容易となる。また、同時にポリシリコン薄膜の間の耐圧が上がり高電圧が印加し易くなるため、アルカリイオン含有ガラス薄膜の膜厚が

薄くとも接合が容易になる。

【0073】(3) 前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面に反射膜を設けたことを特徴とする前記(1)項若しくは、(2)項に記載の微小流路素子。

【0074】本発明は、第3の実施形態に対応する。

【0075】本発明の微小流路素子は、前記(1)項及び、(2)項の作用・効果に加え、一方の面にシリコン薄膜を有しているため、シリコン薄膜で覆われていない他方の面から検出光を入射しその反射光を検出して分析する際、光の反射率が高くなり検出感度が向上する。

【0076】(4) 前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面の前記流路に掛かる位置に複数の開口部を有する、光反射層若しくは光吸収層のいずれか一方を具備することを特徴とする前記(1)項若しくは、(2)項に記載の微小流路素子。

【0077】本発明は、第4の実施形態に対応する。

【0078】本発明の微小流路素子は、素子の両面にシリコン薄膜を複数パターンニングして構成した窓を有している。該窓は一方の面から光を入射し他方の面から透過光を検出する観測窓として働くため、光学的分析の際、特に検出光を集光しなくとも流路の特定の部位を通過する物質の検出が可能となる。特に観察窓を微小にすることにより、微小エリアの分析が可能となる。

【0079】(5) 前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方の外面の前記流路に掛かる位置で、前記流路の液体が流れる方向に、複数の開口部を前記流路の目盛りとして備える、光反射層若しくは光吸収層のいずれか一方を具備することを特徴とする前記(4)項に記載の微小流路素子。

【0080】本発明は、第5の実施形態に対応する。

【0081】本発明の微小流路素子は、素子の一方面または両面に流路に沿って一定間隔を開けて複数パターンニングされた窓を有しており、該複数パターンによって流路の目盛が形成されている。該窓は泳動状況を観測する定規として働き、分析対象物の泳動状況の追跡が容易となる。

【0082】(6) 前記光反射層若しくは光吸収層に設けられた開口部の石英ガラス基板の流路内側に、凹部を設けたことを特徴とする(3)項に記載の微小流路素子。

【0083】本発明は、第6の実施形態に対応する。

【0084】本発明の微小流路素子は、流路の内側に凹部を有しているため、凹部に検出光を入射し光学検出を行うと、検出部の光路長が長くなり検出感度が向上する。

【0085】(7) 前記微小流路素子の石英ガラス基板の非接合面側の少なくとも一方面上に、凸形状の突起を備えることを特徴とする前記(1)項若しくは(2)項に記載の微小流路素子。



【0086】本発明は、第7の実施形態に対応する。

【0087】本発明の微小流路素子は、素子の両面に凸レンズ形状の突起部を有している。該突起部は一方面の突起部から光を入射し他方面の突起部から透過光を検出すると、入射光を集光する働きがあり検出感度が向上する。

【0088】

【発明の効果】以上詳述したように本発明によれば、紫外から可視の波長域に渡って、光学的検出が可能であり、且つ容易に小型化が可能な機器分析用流体流路を有する微小流路素子を提供することができる。

【図面の簡単な説明】

【図1】本発明による第1の実施形態としての微小流路素子の概略的な構成を示す図である。

【図2】図2(a)～(h)は、微小流路素子の形成工程について説明するための図である。

【図3】図3(a)～(f)は、図2に続く微小流路素子の形成工程について説明するための図である。

【図4】第2の実施形態としての微小流路素子の概略的な構成を示す図である。

【図5】第3の実施形態としての微小流路素子の概略的な構成を示す図である。

【図6】第4の実施形態としての微小流路素子の概略的な構成を示す図である。

【図7】図7(a)は、図6に示した微小流路素子を上

面からみた構成を示す図、図7(b)は、図7(a)のA-A線の断面の構成を示す図である。

【図8】図8(a)～(e)は、図6に示した微小流路素子の形成工程について説明するための図である。

【図9】第5の実施形態としての微小流路素子の概略的な構成を示す図である。

【図10】図10(a)は、図9に示した微小流路素子を上面からみた構成を示す図、図10(b)は、図10(a)に示すA-A線の断面の構成を示す図である。

【図11】第6の実施形態としての微小流路素子の概略的な構成を示す図である。

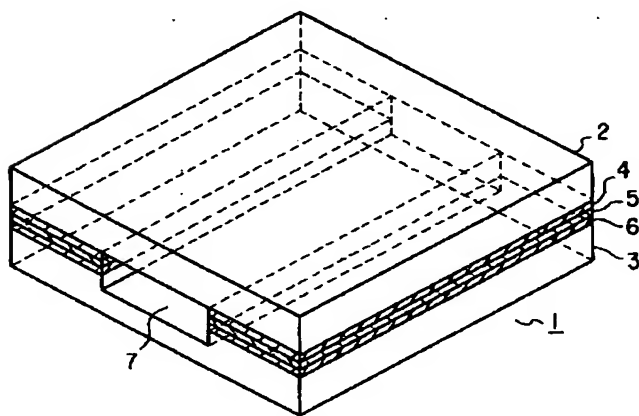
【図12】第7の実施形態としての微小流路素子の概略的な構成を示す図、

【図13】図13(a)は、図12に示した微小流路素子を上面からみた構成を示す図、図13(b)は、図13(a)に示すA-A線の断面の構成を示す図である。

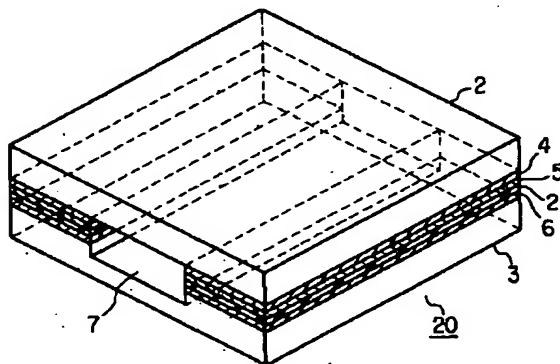
【符号の説明】

- 1…微小流路素子
- 2, 3…石英ガラス基板
- 4, 6…ポリシリコン薄膜
- 5…ホウケイ酸ガラス薄膜
- 7…流体流路
- 8…レジスト薄膜
- 9…溝
- 8a…レジストマスク

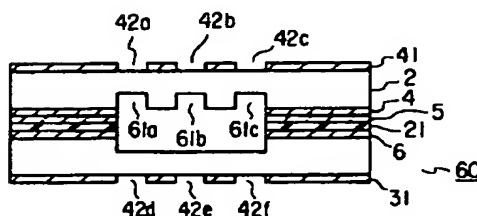
【図1】



【図4】

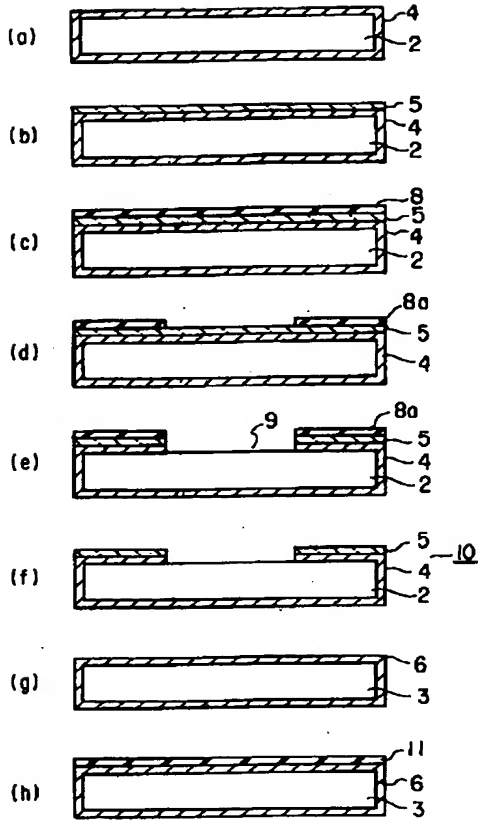


【図11】

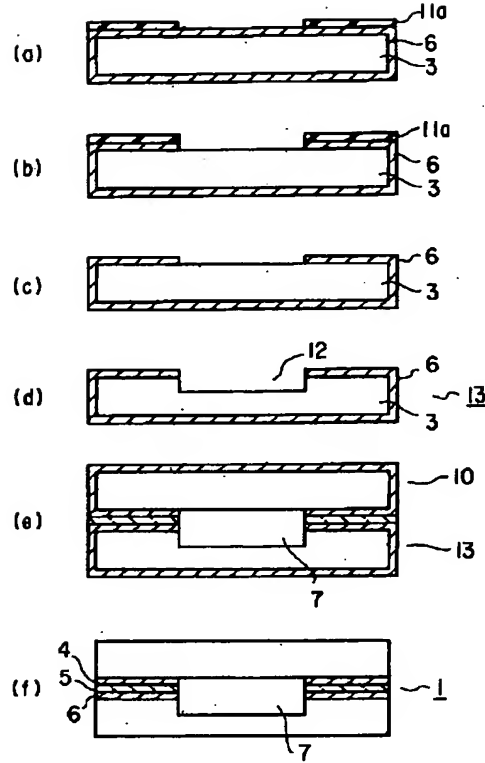




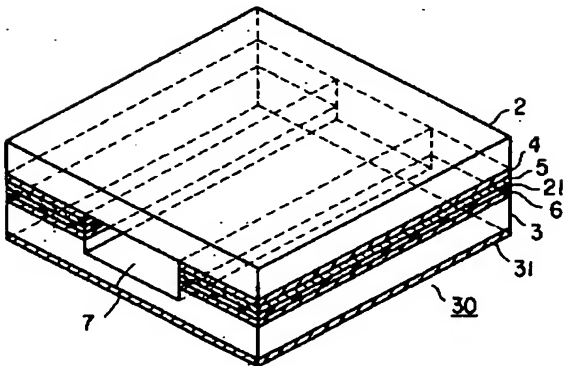
【図 2】



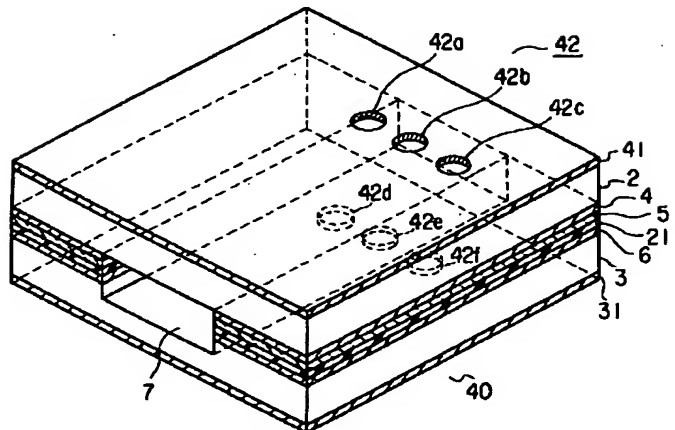
【図 3】



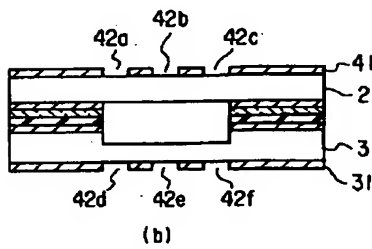
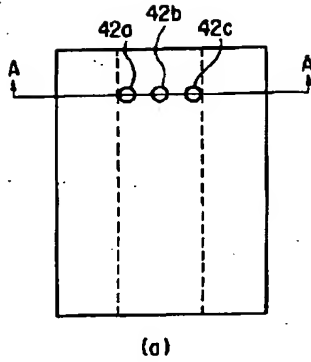
【図 5】



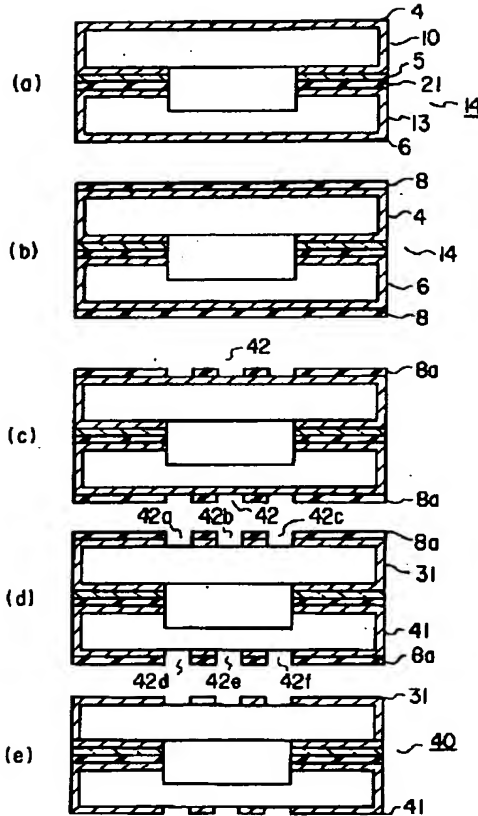
【図 6】



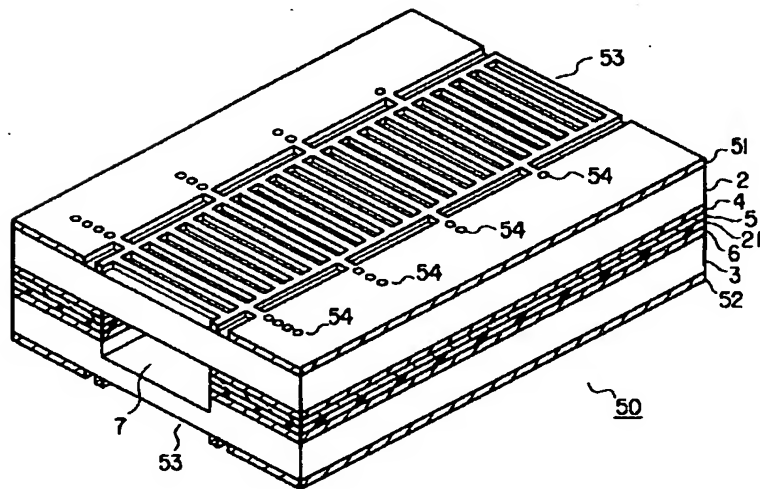
【図7】



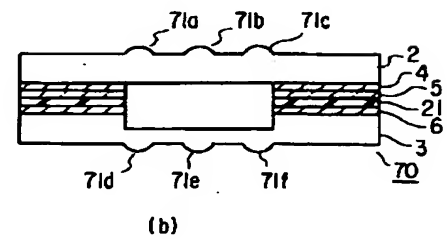
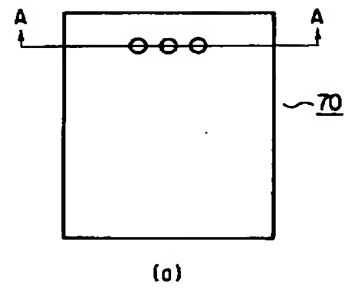
【図8】



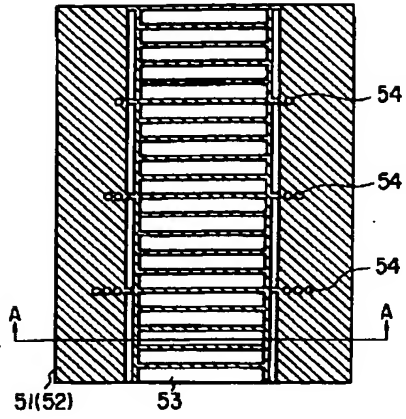
【図9】



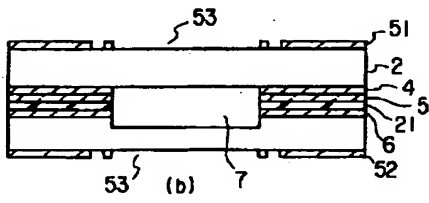
【図13】



【図 10】

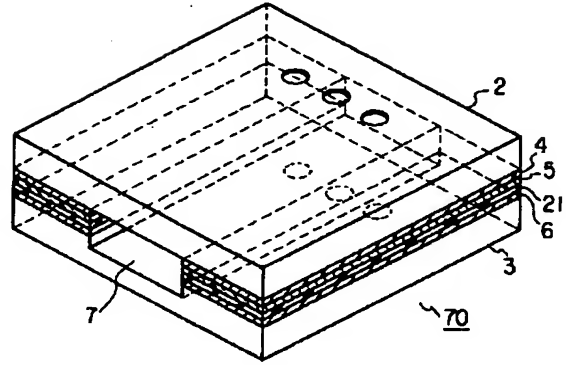


(a)



(b)

【図 12】



【公報種別】特許法第17条の2の規定による補正の掲載  
【部門区分】第6部門第1区分  
【発行日】平成14年6月26日(2002. 6. 26)

【公開番号】特開平10-288580  
【公開日】平成10年10月27日(1998. 10. 27)  
【年通号数】公開特許公報10-2886  
【出願番号】特願平9-95864  
【国際特許分類第7版】

G01N 21/05

H01L 49/00

【F I】

G01N 21/05

H01L 49/00

【手続補正書】

【提出日】平成14年3月19日(2002. 3. 19)

【手続補正1】

【補正対象書類名】明細書

【補正対象項目名】特許請求の範囲

【補正方法】変更

【補正内容】

【特許請求の範囲】

【請求項1】 対向する側の少なくとも一方向に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面に接する面を除き、対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在し、両シリコン層に接して形成されるアルカリイオン含有ガラス層と、を具備し、一体的に接合されることを特徴とする微小流路素子。

【請求項2】 対向する側の少なくとも一方向に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面に接する面を除き対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在して、一方のシリコン層に接して形成されるアルカリイオン含有ガラス層と、前記一対のシリコン層間に介在して、他方のシリコン層及び前記アルカリイオン含有ガラス層とに接して形成されるシリコン酸化膜と、を具備し、一体的に接合される

ことを特徴とする微小流路素子。

【請求項3】 前記微小流路素子の石英ガラス基板の非接合面側の一方の面に光反射層若しくは光吸収層のいずれか一方を設けたことを特徴とする請求項1若しくは、請求項2に記載の微小流路素子。

【手続補正2】

【補正対象書類名】明細書

【補正対象項目名】0013

【補正方法】変更

【補正内容】

【0013】

【課題を解決するための手段】本発明は上記目的を達成するために、対向する側の少なくとも一方向に流路を形成する溝が設けられる一対の石英ガラス基板と、前記一対の石英ガラス基板の対向する側の面で、前記溝内面に接する面を除き、対峙する面上に形成される一対のシリコン層と、前記一対のシリコン層間に介在し、両シリコン層に接して形成されるアルカリイオン含有ガラス層とを備え、一体的に接合される微小流路素子を提供する。

【手続補正3】

【補正対象書類名】明細書

【補正対象項目名】0014

【補正方法】変更

【補正内容】

【0014】さらにこの微小流路素子は、対向して接合する石英ガラス基板の非接合面側の少なくとも一方の面に光反射層若しくは光吸収層のいずれか一方を備える。